AD-A112 957 ARINC RESEARCH CORP ANNAPOLIS MD F/G 17/7

COST ANALYSIS OF THE DISCRETE ADDRESS BEACON SYSTEM FOR THE LOW--ETC(U)

SEP 81 S KOWALSKI, K PETER, A SCHUST, D SWANN DOT-FA76WA-3788

UNCLASSIFIED 1326-01-15-2529 DOT/FAA/RD-81/61 NL

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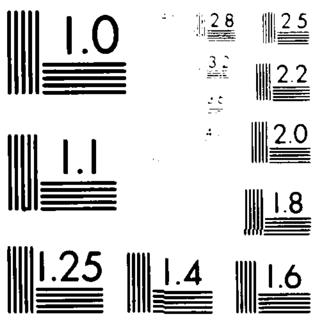
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DOT/FAA/RD-81/61

Office of Systems Engineering
Management and Systems
Research and Development
Service
Washington, D.C. 20590

Cost Analysis of the Discrete Address Beacon System for the Low-Performance General Aviation Aircraft Community

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September 1981

Final Report

This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No. DOT/FAA/RD-81/61	2. Government Accession No. AD	3. Recipient's Catalog No.
4. Title and Subtitle Cost Analysis of the Discrete Address Beacon System for the Low-Performance General Aviation Aircraft Community		5. Report Date September 1981
		6. Performing Organization Code
7. Author(s) S. Kowalski, K. Peter, A. Schust, D. Swann, P. Young		8. Performing Organization Report No. 1326-01-15-2529
9. Performing Organization Name and Address ARINC Research Corporation, a Subsidiary of Aeronautical Radio, Inc., 2551 Riva Road, Annapolis, Maryland 21401		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DOT-FA76WA-3788
12. Sponsoring Agency Name and Address U.S. Department of Transportation, Federal Aviation Administration, Office of Systems Engineering Management and Systems Research and Development Service, Wash., D.C. 20591		13. Type of Report and Period Covered FINAL REPORT
		14. Sponsoring Agency Code ARD-200
15. Supplementary Notes		

16. Abstract

This report presents the results of cost analysis of various Discrete Address Beacon System (DABS) configurations that may be implemented for the low-performance general aviation aircraft community. The DABS designs considered in this analysis were developed by ARINC Research Corporation using state-of-the-art technology.

17. Key Words DABS, Costs	18. Distribution Statement This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	364	

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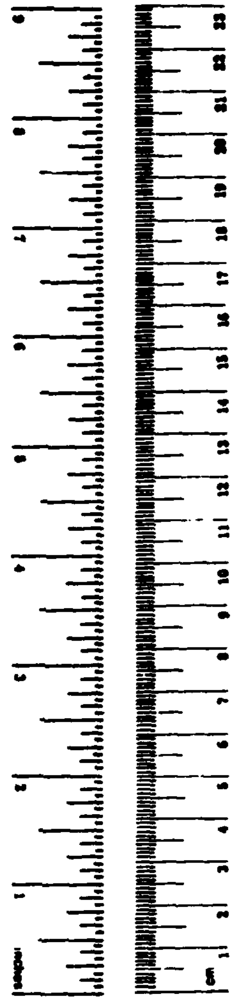
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

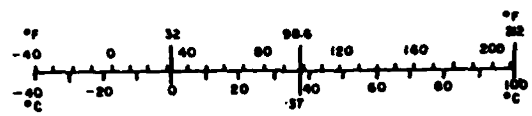
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



ACKNOWLEDGMENT

Throughout this study, ARINC Research Corporation received enthusiastic and invaluable support from the engineering and management staffs of the Federal Aviation Administration, Bendix Avionics, King Radio, and NARCO Avionics. Special acknowledgment is made to R. Jones, E. Lucier, and J. Scardina of the FAA and to D. Bowers, formerly of the FAA.

SUMMARY

This study has developed costs for various Discrete Address Beacon System (DABS) transponder configurations using both discrete and LSI components to assess the cost impact of varying levels of sophistication in a DABS transponder designed for the low-performance general aviation community (single-engine and light twin-engine aircraft). The cost of encoding altimeters was not included in transponder configuration costs. ARINC Research Corporation performed this work under Contract DOT-FA76WA-3788 for the Federal Aviation Administration.

Costs were developed for nine levels of sophistication in the DABS transponder ranging from basic surveillance to a version with Comm A, B, and C and ATARS. ARINC Research Corporation based all designs of transponder configurations on the DABS Draft National Standard of February 1980 with updates where practicable and technical details may not conform to the final DABS National Standard. The ATARS portion of the design is based on FAA SRDS Technical Letter Report No. RD-80-11-LR of April 1980 and the Revised Draft ATARS National Aviation Standard of December 17, 1980. Costs were also developed for a commercially available Air Traffic Control Radar Beacon System (ATCRBS) as a method to verify the cost model.

We used the cost and reliability data derived from our DABS designs to develop the individual aircraft costs and the combined user-community costs of DABS implementation. Calculations of the transponder costs were based on the accounting method of cost estimating. The production cost data were developed through detailed analysis of the methods of several leading avionics manufacturers producing either high- or low-performance aircraft equipment. Total system costs were evaluated with the aid of an economic analysis model.

Tables S-1 through S-3 summarize the DABS cost analysis. Table S-1 identifies the costs of the various DABS configurations in constant 1980 dollars. The values shown are the expected selling price of each configuration, including appropriate markups for distribution. Table S-2 presents the cost per aircraft, also in constant 1980 dollars. Distribution costs have also been included in the data presented. The unit acquisition cost shown in Table S-2 is different from the acquisition cost illustrated in Table S-1 because the life-cycle-cost model allows for the normal distributor discount offered when the distributor installs the avionics in the aircraft. Table S-3 summarizes the total expenditure required to implement

Table S-1. ACQUISITION COST OF TRANSPONDERS (IN CONSTANT 1980 DOLLARS)		
Transponder Configuration	Components	
	Discrete	LSI
ATCRBS	718	--
Basic Surveillance DABS	1,614	1,239
Basic DABS with Antenna Diversity	2,054	1,679
Basic DABS with 21.5 dBW Antenna	1,617	1,242
DABS with Comm A and B	1,663	1,293
DABS with Comm A and B and ATARS	2,093	1,592
DABS with Comm A and B, ATARS, and BCAS Interface	2,167	1,592
DABS with Comm A, B, and C	1,830	1,413
DABS with Comm A, B, and C and ATARS	2,261	1,719
DABS with Comm A, F, C, and D	2,227	1,781

the airborne portion of DABS. Table S-3 costs are presented in two ways: in constant 1980 dollars and with a 10 percent discount rate in accordance with OMB Circular A-94.

Since each transponder configuration is unique, requiring a design that optimizes the data processing for that configuration, the difference between any set of costs in Table S-1 should not be considered as the expected cost of adding the additional capability. For example, the cost of adding the ATARS capability to an existing DABS transponder with Comm A and B capability cannot be considered as being only $430, the difference in cost between the two versions. Rather, the cost of the DABS with ATARS can be expected to be $2,093 if designed originally into the system, and the cost of DABS without ATARS would be only $1,663. Development costs for LSI technology are not included in the tables; therefore, the cost advantage for each design when LSI technology is introduced must be considered only after the development cost of LSIs is amortized during the early part of transponder introduction. Depending on the configuration, amortization cost would add approximately $114 to $143 to the list price of a transponder during the first two years.

Table S-2 shows that the cost of any DABS configuration is mainly influenced by the acquisition cost of the transponder. The installation cost is the same for any configuration and the recurring logistic costs are similar. (Antenna diversity and Comm A, B, C, and D have higher recurring logistic costs than the other configurations.)

Table S-3 illustrates the variance in total life-cycle costs between transponder configurations. The cost variance between configurations may

Table S-2. COMPARISON OF AIRCRAFT TRANSPONDER COST DATA FOR LOW PERFORMANCE GENERAL AVIATION (PER AIRCRAFT INSTALLATION IN CONSTANT 1980 DOLLARS)

System	Acquisition	Installation		Recurring (Annual)	First Year of Ownership		Life-Cycle Cost	
		New	Retrofit	Logistic	New	Retrofit	New	Retrofit
Discrete Version								
Basic DABS	1,303	195	264	18	1,516	1,585	1,768	1,837
Diversity	1,655	242	344	30	1,927	2,029	2,347	2,449
21.5 dBW Antenna Power	1,305	195	264	18	1,518	1,587	1,770	1,837
Comm A and B	1,342	195	264	19	1,556	1,625	1,822	1,891
Comm A and B and ATARS	1,686	195	264	18	1,899	1,968	2,151	2,220
Comm A and B, ATARS, and BCAS Interface	1,745	195	264	19	1,959	2,028	2,225	2,294
Comm A, B, and C	1,476	195	264	18	1,689	1,758	1,941	2,010
Comm A, B, and C and ATARS	1,820	195	264	19	2,034	2,103	2,300	2,369
Comm A, B, C, and D	1,793	195	264	22	2,010	2,079	2,318	2,387
LSI Version								
Basic DABS	1,003	195	264	17	1,215	1,284	1,453	1,522
Diversity	1,355	242	344	28	1,625	2,017	1,727	2,119
21.5 dBW Antenna Power	1,005	195	264	17	1,217	1,286	1,455	1,524
Comm A and B	1,045	195	264	17	1,257	1,326	1,495	1,564
Comm A and B and ATARS	1,285	195	264	17	1,497	1,566	1,735	1,804
Comm A and B, ATARS, and BCAS Interface	1,285	195	264	17	1,497	1,566	1,735	1,804
Comm A, B, and C	1,142	195	264	16	1,353	1,422	1,577	1,646
Comm A, B, and C and ATARS	1,386	195	264	17	1,598	1,667	1,836	1,905
Comm A, B, C, and D	1,436	195	264	21	1,652	1,721	1,946	2,015

Table S-3. SUMMARY OF LIFE-CYCLE COSTS FOR DABS TRANSPONDERS FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY		
Transponder Configuration	Constant 1980 Dollars (In Millions)	Discounted 1980 Dollars (In Millions)
Discrete Version		
Basic Surveillance DABS	684.3	195.8
Basic DABS with Antenna Diversity	891.3	253.7
Basic DABS with 21.5 dBW at Antenna	685.2	196.1
DABS with Comm A and B	700.3	200.4
DABS with Comm A and B and ATARS	838.7	240.9
DABS with Comm A and B, ATARS, and BCAS Interface	862.9	247.9
DABS with Comm A, B, and C	750.9	215.4
DABS with Comm A, B, and C and ATARS	893.5	256.8
DABS with Comm A, B, C, and D	896.6	256.9
LSI Version		
Basic Surveillance DABS	558.4	159.3
Basic DABS with Antenna Diversity	765.1	217.2
Basic DABS with 21.5 dBW at Antenna	567.1	159.6
DABS with Comm A and B	575.9	164.4
DABS with Comm A and B and ATARS	670.4	192.1
DABS with Comm A and B, ATARS, and BCAS Interface	670.4	192.1
DABS with Comm A, B, and C	610.9	174.9
DABS with Comm A, B, and C and ATARS	715.4	205.0
DABS with Comm A, B, C, and D	746.7	213.5

be traced directly to the acquisition cost of the transponders. Adding ATARS to a discrete component configuration results in an increase in life-cycle cost of approximately 19 percent over a similar configuration without ATARS. In LSI configurations there is an increase in cost of approximately 16 percent with the addition of ATARS. The most costly configuration is DABS with Comm A, B, C, and D.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

The Federal Aviation Administration (FAA) has sponsored the development of the Discrete Address Beacon System (DABS) as a near-future replacement of the Air Traffic Control Radar Beacon System (ATCRBS) surveillance system. DABS, by design, will be capable of providing surveillance, communications, and, when combined with the Automatic Traffic Advisory and Resolution Service (ATARS), collision avoidance information to aircraft within areas of coverage. DABS avionics have been specified for the full-capability user, but their capability and cost have not been specified for the low-performance general aviation aircraft users. Such specifications are vital because the largest user of avionics is the general aviation community, primarily the single-engine and light twin-engine low-performance aircraft.

The Systems Research and Development Service (SRDS) in conjunction with the Office of Systems Engineering Management (OSEM) of the FAA tasked ARINC Research Corporation, under Contract DOT-FA76WA-3788, to develop a family of designs to be used for cost analysis of DABS transponders for low-performance general aviation aircraft. The cost of encoding altimeters was not included in transponder configuration costs. The designs were to include the basic surveillance capability, communications capability, and ATARS capability. Using those designs ARINC Research Corporation was to develop the engineering, manufacturing, distribution, and support costs for the DABS transponders to estimate a retail selling price. This projected retail price was to be used to calculate the cost of ownership of the transponder over its life cycle.

1.2 PROJECT OVERVIEW

The overall objective of this project was to identify the cost of manufacturing the DABS transponders to be used by low-performance general aviation aircraft. For comparison, the life-cycle costs (LCC) of the DABS transponders were to be evaluated for a typical period of ownership. To meet this objective, it was necessary to design a DABS transponder to provide a basis for subsequent cost analysis. Since it was the intent of the FAA to achieve a retail cost appropriate for present low-performance general aviation aircraft avionics, the analysis was structured to identify various levels of sophistication with their associated costs to the users.

ARINC Research Corporation developed the designs and costs for nine levels of sophistication in the DABS transponder. These designs were developed with both discrete and LSI logic, and costs were estimated by traditional accounting methods. The total LCC was calculated by use of a modification of the economic analysis model (EAM) we developed under Contract DOT FA74WA-3506. This report presents the results of the analysis and the constraints applied to ensure uniformity in the development of the transponder costs. The study results are presented in 1980 dollars, consistent with the technology and available data on which the estimates were made.

1.3 ORGANIZATION OF THE REPORT

The seven chapters of this report address the transponder designs and the techniques used for estimating the unit and life-cycle costs of the designs and presents the results of the analysis.

Chapter Two describes the overall approach to developing the economic evaluations and the modeling method used to obtain the desired unit and life-cycle costs.

Chapter Three describes the development of the cost, reliability, and design data for the different complexity levels of the DABS transponders for both the discrete and LSI designs.

Chapter Four addresses the LCC model used for this study.

Chapters Five and Six address the results of the LCC study and a sensitivity analysis of them.

Chapter Seven summarizes the results of the analysis and presents conclusions derived from the analysis.

Appendix A provides the detailed cost sheets associated with the analysis, Appendix B describes the LCC model, Appendix C presents the LCC model, Appendix D addresses the common parameters used in the LCC, and Appendix E contains the DABS design sheets.

CHAPTER TWO

APPROACH

The costs of the various DABS configurations were developed in a manner that would allow comparison between the configurations in the costs of acquisition, installation, and logistic support. Identical scenarios were employed (e.g., time of implementation and aircraft statistics) to assure that cost benefits associated with the different configurations would be readily comparable.

The development of detailed and accurate cost analyses of avionics equipments that currently exist only in prototype form can pose a number of formidable problems, including the following:

- Conversion of Engineering Requirements to Production Configuration of Equipment. The system concepts are in various stages of evaluation and employ existing technology levels. Evaluation criteria must be used that take into account these limitations to ensure that the study evaluates production-quality equipments.
- Anticipation of the Needs of the Aviation Community. The costs of any new equipment are controlled by the demand for the product. The demand for DABS transponders had to be identified over a given time frame to permit estimation of production quantities and to justify development of the microelectronics necessary for cost-effective manufacture of these transponders. Therefore, it has been necessary in the study to limit the implementation schedule to a realistic time span.
- Development of the Necessary Additional Data Required for a Comprehensive Cost Analysis. Although the development of data (such as aircraft fleet sizes) that apply equally to any DABS configuration is of the lowest criticality in a comparative cost evaluation, it is extremely important to the accurate development of total implementation costs.

The general approach followed by ARINC Research Corporation in resolving these problems and obtaining the economic evaluation of the DABS configurations is illustrated in Figure 2-1.

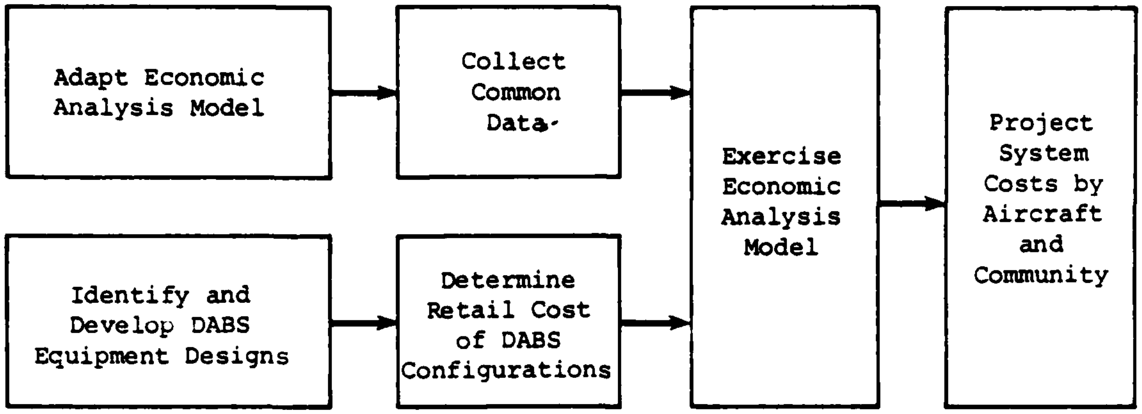

Figure 2-1. DABS ECONOMIC ANALYSIS APPROACH

An existing ARINC Research economic analysis model was adapted to evaluate the DABS implementation scenario. Parallel data-collection efforts were then initiated to obtain the common and system-peculiar input data needed to exercise the model. The common data, such as aircraft populations, installation costs, and maintenance scenarios, were developed or obtained from existing FAA documents. The model was also exercised for key parameter variation cases in order to investigate the sensitivity of the results obtained to the input data and to the assumptions employed in the analysis. The outputs of each model exercise were the resultant acquisition, installation, support, and total costs, by aircraft and for the total user-community, for each year and cumulatively for the 15 years from 1987 through 2001.

The remainder of this chapter gives details of how this task was approached.

2.1 SYSTEM CONCEPT

The Discrete Address Beacon System is a cooperative surveillance and communications system for air traffic control. It employs ground-based interrogators and airborne transponders. Data-link communications are integrated with surveillance interrogations and replies. DABS has been designed as an evolutionary replacement for the current Air Traffic Control Radar Beacon System to provide the surveillance and communications capability required for air traffic control in the projected 1995 traffic environment. DABS uses the same frequencies for interrogation and replies as ATCRBS. The DABS transponder must reply to both ATCRBS and DABS interrogations, and it provides an interface with a variety of data-link message display and input devices.

The communications capability provides an air-to-air data link for the Beacon Collision Avoidance System (BCAS) and the ability to receive and respond to the Automatic Traffic Advisory and Resolution Service (ATARS).

Chapter Three of this study describes the development of the DABS transponder configurations and the costs and reliabilities associated with the equipments.

2.2 REQUIRED AVIONIC EQUIPMENTS

This study was limited to an evaluation of the cost and reliability of the airborne equipments required to provide the DABS function for the low-performance general aviation aircraft. The equipments consisted of several DABS transponder configurations and miscellaneous hardware required for their proper installation and operation. The transponders have the operational characteristics defined by the Draft DABS National Standard of February 1980 and have been updated where feasible to reflect changes in later versions of that standard. The ATARS portion of the design is based on FAA SRDS Technical Letter Report No. RD-80-11-LR of April 1980. The revised ATARS Draft National Aviation Standard of December 17, 1980, also was considered in relation to the ATARS design. Equipment design allows for expected technological advances in the near future and uses proven existing transponder concepts where they are economically advantageous.

2.3 RETAIL COST METHOD

The cost evaluation technique chosen was the industry standard accounting method of calculating production costs on the basis of estimates of the numbers and types of piece parts. The method requires detailed bills of material and associated labor units, schematic diagrams, mechanical and electronic module layouts, and an estimate of the total quantity of units to be manufactured. Material costs were based on original equipment manufacturer (OEM) price lists for quantities of 1,000 or greater, and allowances were made for discounts available for large parts procurements common to equipment manufacturers. Finally, the accounting structures of potential manufacturers had to be known to allow for labor, overhead charges, quality-control costs, general and administrative expenses, and the usual profits earned in the avionics industry.

The data necessary for the preparation of the cost-estimating worksheets are usually taken directly from engineering bills of material. The component part numbers are identified and quantities entered on the worksheets. Procurement costs of the components are obtained either from OEM price lists or, where the component is unique or has a high cost, through direct quotes provided by distributors. Labor associated with fabrication or assembly of components is estimated in hours per 1,000 units for a mass production assembly line. Historical data maintained by most manufacturers provide the average labor estimates for both manual and automatic insertion processes. These data provide the average amount of labor associated with assembly of components configured in a module (e.g., printed circuit card) or subassembly. The total labor hours are evaluated to compare the complexity of the assembly with historical data. If the module is complex (that is, it has a high component density or requires printed circuit boards with multiple layers), a compensating factor is applied to the labor estimate. The resultant material costs and labor estimates provide the data necessary for cost estimates.

The worksheets used in developing total equipment costs are structured to provide cost information on individual modules (or subassemblies) and total avionics units. Costs are displayed in that fashion to provide information that is useful in evaluating life-cycle costs where module stockage and associated costs are necessary for determining the recurring and non-recurring logistics costs. Total avionics unit costs include unit assembly, test, and integration costs.

Developed costs include the expense of materials, material handling charges, labor at either known or estimated hourly rates, average overhead obtained from a sampling of avionics manufacturers, and factory inspection costs during production. The addition of general and administrative (G&A) costs, together with a reasonable profit, provides the OEM or selling price of the unit. This is the cost distributors handling the product or large fleet owners buying avionics at quantity prices expect to pay. Private aircraft owners usually purchase avionics from distributors and pay an additional distributor handling markup of 100 percent.

The output data sheets are also structured to permit easy reevaluation of the expected costs of avionics by substituting different labor, overhead, G&A, profit, and markup rates if there is justification or if a manufacturer prefers to use the exact factory rates rather than the average of the industry.

2.4 DEVELOPMENT OF ECONOMIC ANALYSIS MODEL

The specific means of assessing the projected costs associated with each of the DABS configurations was through the development and exercise of a computer-based cost model. This model determined the annual and cumulative costs associated with each DABS system type and tabulated these costs by aircraft and for the total user community. The model was developed by tailoring existing ARINC Research cost models to the specific characteristics of the DABS concepts and the low-performance general aviation aircraft community.

The input data to the EAM consist of two types: data that are unique to the particular DABS configuration being evaluated and data that are common to all of the configurations being evaluated. The specific requirements for each type of data were defined concurrently with the development of the model, and data were collected.

After the data had been collected, the model was exercised for each system concept in the user community. In addition, the EAM was exercised to determine the sensitivity of the results obtained to variations in key parameters (e.g., MTBF).

2.5 COMMON DATA ELEMENTS

The data common to all of the DABS concepts consist of four basic types: (1) installation costs, (2) aircraft fleet size projections, (3) aircraft equipment configurations, and (4) user operation and maintenance

parameters (e.g., average flying hours per month, labor rates, pipeline times).

The cost of installing transponders in new aircraft was assumed to be 60 percent of retrofit costs. The installation costs for the general aviation community were therefore determined by updating general aviation retrofit costs developed for previous ARINC Research studies.

Aircraft fleet size projections for the general aviation user community were obtained by analyzing data from various FAA reports and projections and linearly extrapolating the data through 2001.

Estimates of the common data elements peculiar to the general aviation community were developed from information ARINC Research gained in earlier similar studies.

2.6 APPROACH SUMMARY

The preceding sections have provided an overview of the technical approach used in the study, outlined the capabilities of the EAM, described its use, and identified the general types of data to be used in the evaluation. The succeeding chapters of this report describe in detail the DABS configurations, the retail costs, the characteristics of the EAM, and the specific results of the study.

CHAPTER THREE

TRANSPONDER CONFIGURATIONS, COST, AND RELIABILITY DEVELOPMENT

The introduction of the DABS transponder to the low-performance general aviation aircraft population will result in user investment costs to attain a degree of performance necessary for the safe and efficient use of the National Air Space (NAS). DABS is capable of providing services ranging from surveillance only to complete communications using the integral data link; the level of capability desired by the users will depend on the costs associated with the different levels. This chapter identifies the capabilities recommended by the FAA and evaluates the acquisition costs associated with each design of the DABS transponder.

3.1 TRANSPONDER CONFIGURATIONS

The DABS transponder is intended to replace the Air Traffic Control Radar Beacon System transponder in providing the secondary surveillance functions of position and altitude reporting. In addition, when the 112-bit capability of the data link is included in the transponder, the system can support not only general purpose data link but also aircraft separation and collision avoidance advisories as part of the ATARS implementation. Since the transponder will be operating in an environment that includes BCAS equipment, provisions have been made in the DABS National Standard for exchange of information between DABS and BCAS equipment on status of displays and complimentary maneuvers. Finally, the extended length message (ELM) capability of the DABS concept is introduced to identify the potential cost of a transponder that is capable of supporting the widest range of DABS data link services. Since each of the capabilities requires specialized data processing with the airborne transponder, separate designs that provide the desired capabilities have been developed during the course of this study. This has resulted in the nine levels of DABS transponder configurations listed below and discussed in this section:

- Baseline DABS
- Baseline DABS with antenna diversity
- Baseline DABS with 21.5 dBw power output at antenna
- DABS with Comm A and B
- DABS with Comm A and B and ATARS
- DABS with Comm A and B, ATARS, and BCAS interface

- DABS with Comm A and B and uplink ELM (Comm C)
- DABS with Comm A and B, ATARS, and uplink ELM (Comm C)
- DABS with Comm A and B, and uplink/downlink ELM (Comm C and D)

Figure 3-1 presents a functional description of the entire DABS transponder. The diagram displays in detail the interconnection of various modules of the baseline system. Each of the various system configurations resulting from adding complexity is indicated by a single functional block (e.g., ATARS) and connected to the appropriate circuitry in the baseline transponder. The intent of Figure 3-1 is to show the interrelationships of the major modules of the DABS transponder; Appendix E contains a detailed discussion of many of these modules. The various DABS configurations are discussed in the following sections.

3.1.1 <u>Baseline DABS</u>

The baseline DABS transponder is designed to meet the surveillance requirements identified in the DABS National Standard responding to the conventional ATCRBS Mode 3A and C interrogations and the 56-bit P6-pulse of the discrete address interrogations. The design conforms to the DABS uplink field format Numbers 0, 2, 4, 5, and 11 as defined in the standard. Special provisions for site lockout, protocol, reply rate limiting, etc., associated with the use of a 56-bit data field of DABS have been included in the decode and encode functions of the logic design.

The transponder has been segmented into modules, or subassemblies; its configuration could be as shown in Figure 3-2. The front end consists of a conventional duplexer and low-pass filter used in modern ATCRBS transponders. The IF amplifier module includes the local oscillator, an expanded logarithmic amplifier, pulse width discriminator, and ditch-digger circuitry. Changes from a conventional logarithmic amplifier include additional intermediate stages to improve discrimination in signal strength and modified ditch-digger circuitry to permit 6 dB discrimination of the P4 pulse.

The differential phase shift keying (DPSK) demodulator utilizes phase-locked loop (PLL) circuitry operating at the 10 MHz IF frequency. Controlled gating is provided from the decoding timing circuit to inhibit false phase reversal from the leading edge of the P6 pulse. The PLL technique was chosen because of cost considerations. Available PLL circuits will operate in the 60 mHz region although the manufacturers of the PLL chips cannot now guarantee settling times required for lock-on to a phase reversal in less than fifteen cycles (settling times up to twenty cycles are typical). The lack of suitable PLL chips for this application stems from a lack of requirements for development rather than inadequate technology. When the logic manufacturers recognize a need, they will develop the necessary hardware.

Output power is developed from a conventional cavity oscillator tube used in modern ATCRBS transponders. The choice of a tube rather than solid-state devices was dictated by cost. Those transponder manufacturers we asked agreed that a transition to solid state would be made when either the

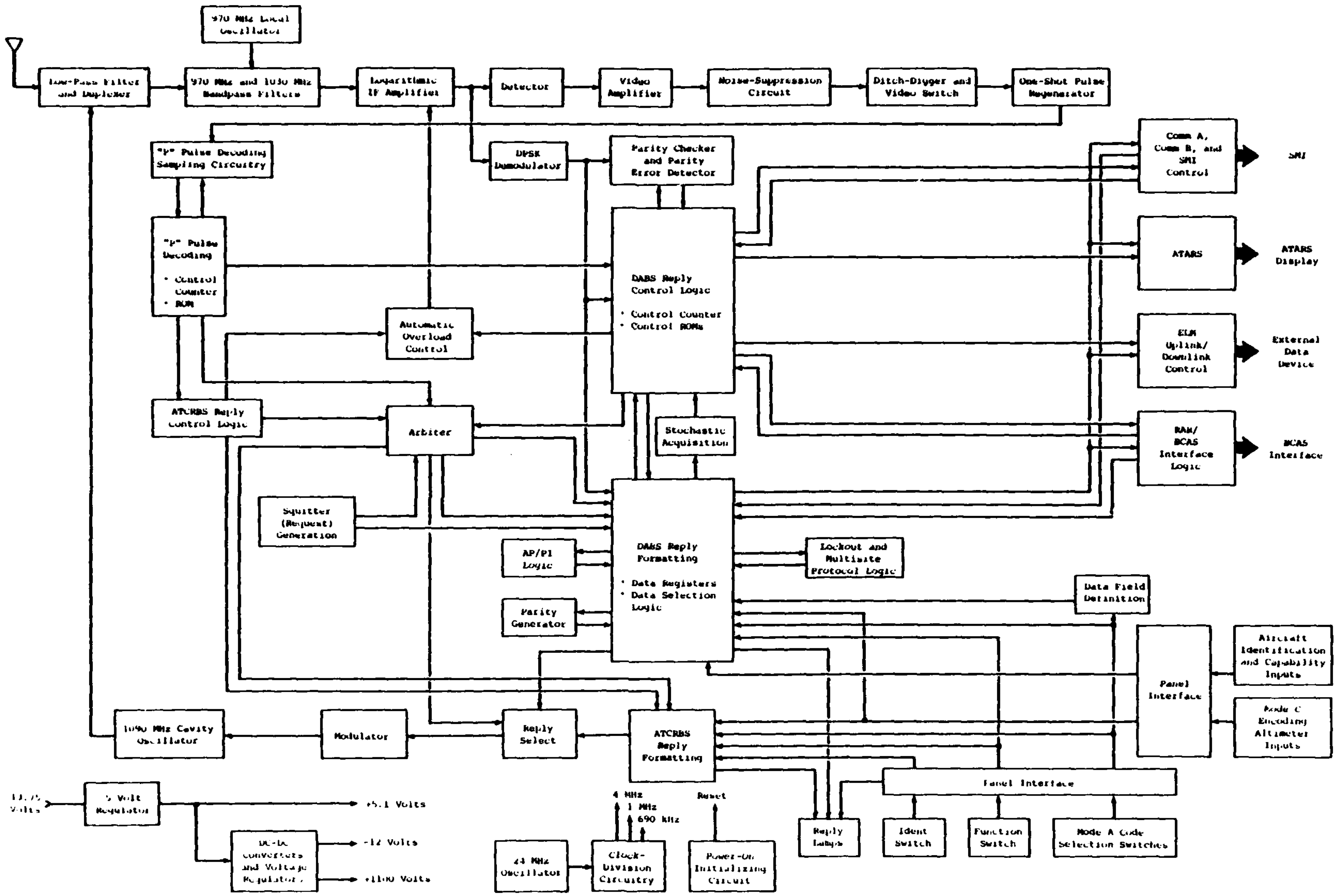

Figure 3-1. DABS FUNCTIONAL DIAGRAM

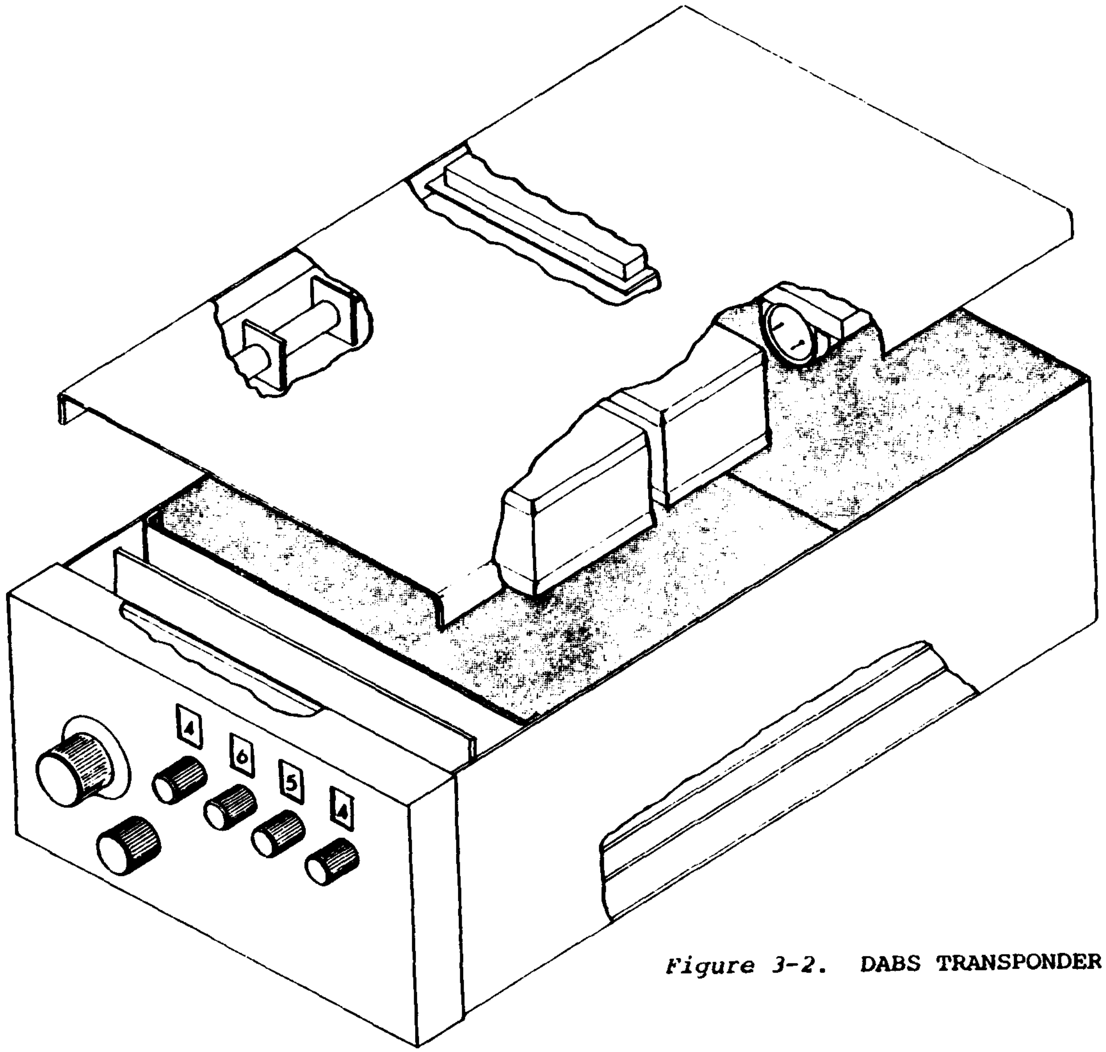

Figure 3-2. DABS TRANSPONDER PACKAGING CONCEPT

cost of solid-state amplifiers fell to the comparable cost of the tube configuration, or the cost of the cavity oscillator increased to the present cost of solid state. For the majority of configurations studied the cavity oscillator tube provides the necessary output characteristics for proper operation of the DABS transponder. Power supplies, however, are affected by each configuration. The power supply was designed to provide 141 watts peak power at the antenna and sufficient capacity in the storage capacitors to meet the reply rates specified in the National Standard. However, even though the capacity exists for the transponder to generate up to 2000 replies per second (consistent with maximum ATCRBS reply rate specifications) it is believed that currently available cavity oscillators are incapable of such a high duty cycle and would break down. Normal reply rates specified (e.g., four percent duty cycle average over a 25-millisecond interval) are well within the capability of the cavity oscillator.

Packaging of the transponder is a critical consideration for a manufacturer since it must compete for limited space in the avionics panel of single-engine aircraft. Modern ATCRBS transponders have been miniaturized to occupy a panel space of 6.25 x 1.63 inches. This typically includes one large printed circuit board and additional RF components. The discrete version of the baseline DABS transponder will require two large printed circuit (PC) boards for the decode/encode function, a small modulator/demodulator board, and a power supply PC board, as well as the RF/IF subassemblies. Since the majority of space is occupied by integrated circuit (IC) chips, the boards can be packaged with minimum separation resulting in a transponder that will require a panel space of 6.25 x 3.5 inches and a depth of approximately 11 inches for the most complex design. Normal mode select and code select switches will be accessible on the front panel as well as various indicator lamps to identify the source of interrogation, reply activity, and transponder status.

3.1.2 Baseline DABS with Antenna Diversity

The introduction of the Beacon Collision Avoidance System has generated the possibility of transponder interrogations from angles other than below the aircraft. Since both antenna shielding and multipath effects could cause either failure to reply or erroneously timed replies, a technique for improving reply reliability must be evaluated. The installation of both bottom- and top-mounted antennas connected to independent RF and IF receivers will permit detection of the stronger interrogator signal for processing and reply. The use of a diversity switch at the output of the logarithmic amplifier controlled by signal strength will allow processing of only the desired interrogation.

This DABS transponder configuration is identical to the baseline configuration described in Section 3.1.1 with the following additions to provide diversity operation:

- Two independent receiver sections consisting of a duplexer, low-pass filter, oscillator, and expanded logarithmic amplifier
- Independent video processing

- An analog diversity switch circuitry added to the modulator/demodulator PC board
- An additional modulator controlled by the action of the diversity switch, which selects the same antenna for transmission as for reception
- An additional cavity oscillator tube to provide transponder output power on the chosen antenna

The use of independent receiver stages is conventional for diversity operation since signal strength detection usually occurs at the video stages. However, the dual transmitter concept was chosen after careful review of available RF switches, hybrids, and circulators and the switching times necessary to reply on the selected antenna. When costs of the switching components were compared to the cost of a second modulator and cavity oscillator, the latter configuration proved more economical.

The transponder packaging is not expected to be adversely affected by the addition of the diversity operation and should remain as specified for the baseline case. However, some additional depth may be required.

3.1.3 Baseline DABS with 21.5 dBW at Antenna

The baseline DABS was designed for a nominal output power of 21.5 dBW measured at the terminals of the antenna. This assumed 2 dB cable loss (10 feet of RG-58 cable) between transponder and antenna location. The output power of the cavity oscillator was controlled by the high voltage applied to the tube. At 1100 volts the cavity delivers 225 watts, or exactly 21.5 dBW at the antenna. At maximum operating rating (i.e., 1400 volts) the cavity will provide 325 watts into a characteristic 50-ohm load. If the same 2-dB cable attenuation is considered, the transponder is capable of delivering 23.5 dBW into the antenna. The Draft DABS National Standard distinguishes between aircraft operating limits, requiring the 18.5 dBW minimum for aircraft operating below 15,000 feet and 21.0 dBW minimum for aircraft operating above 15,000 feet. All measurements are made at the antenna. Because of excess power in the baseline DABS, the interest in 21.5 dBW power output is met by operating the cavity oscillator at the typical rated power. A change in the cavity oscillator for higher power is not necessary since the specifications of the Draft National Standard are exceeded.

Since features of the baseline design are identical except for the high-voltage transformer and additional storage capacity in the power supply, the effect of obtaining up to 23.5 dBW at the antenna on transponder design and cost is minimal.

3.1.4 DABS with Comm A and Comm B

The natural expansion of the baseline DABS transponder would affect the data-link capability of the system. The baseline transponder has a limited, highly regimented 56-bit data field to perform surveillance functions. Expansion of the data field to 112 bits provides 56 bits of data for various

communications functions while performing all the surveillance-associated functions of the baseline design. Although message content and codes for the additional 56 bits are not included in the Draft National Standard, it is expected that they will be used for a wide range of data link services including air traffic control information exchange and ATARS advisories. The expansion to include the 56 bits (Comm A and Comm B capability) affects the encode-decode design of the transponder and the power supply capacity and requires the addition of a real-time standard message interface. All other aspects and performance specifications are the same as for the baseline case described in Section 3.1.1.

Since the transponder with a 112-bit data field capability appears to be the more practical design for early implementation, specific details of design have been provided for review and are included in Appendix E. Major emphasis is placed on the digital processing since the remainder of the transponder virtually duplicates a conventional modern ATCRBS transponder. The logic design is primarily TTL using discrete components readily available from a variety of manufacturers. The discrete component approach was chosen for two reasons: the timing considerations associated with a 4-mbps data rate dictated the use of logic suitable for parallel processing, and the need for discrete design which could identify components for conversion to large scale integration (LSI) configurations. Use of existing microprocessor systems was considered but rejected except for specialized functions because of the relatively slow processing capabilities of modern microprocessors.

3.1.5 DABS with Comm A and B and ATARS

Aircraft equipped with DABS transponders capable of processing 112-bit messages have the potential for receiving traffic advisory information on the relative location of proximate and potentially threatening aircraft and resolution advisories when a near-miss or collision is predicted by the automated ground computer system. In order to provide this capability, certain processing and display functions have been added to the transponder configuration described in Section 3.1.4. Details of logic design associated with ATARS capability are included in Appendix E.

The advisory information presented to the pilot conforms to message protocol for ATARS class 0 service, which was defined in the draft ATARS National Aviation Standard (revised 12-17-80 version). Space constraints on the front panel of the transponder limit information to bearing, altitude, and range of two aircraft with the highest proximity or threat (T) priorities. The bearing information is displayed on two seven-segment LED packages providing 12 o'clock relative information of intruder aircraft. Altitude information is provided as being above (HI), below (LO), or at the same altitude (CO). Range is displayed in tenths of nautical miles up to 9.9 nm. Complementing the alphanumeric displays are a set of arrows and Xs providing advisories for vertical and horizontal maneuvers or restrictive maneuvers. The panel layout, together with code and mode selector switches, is shown in Figure 3-3. The 3.5-inch-high panel can accommodate all the control and display functions if thumb-wheel switches are used for code selection.

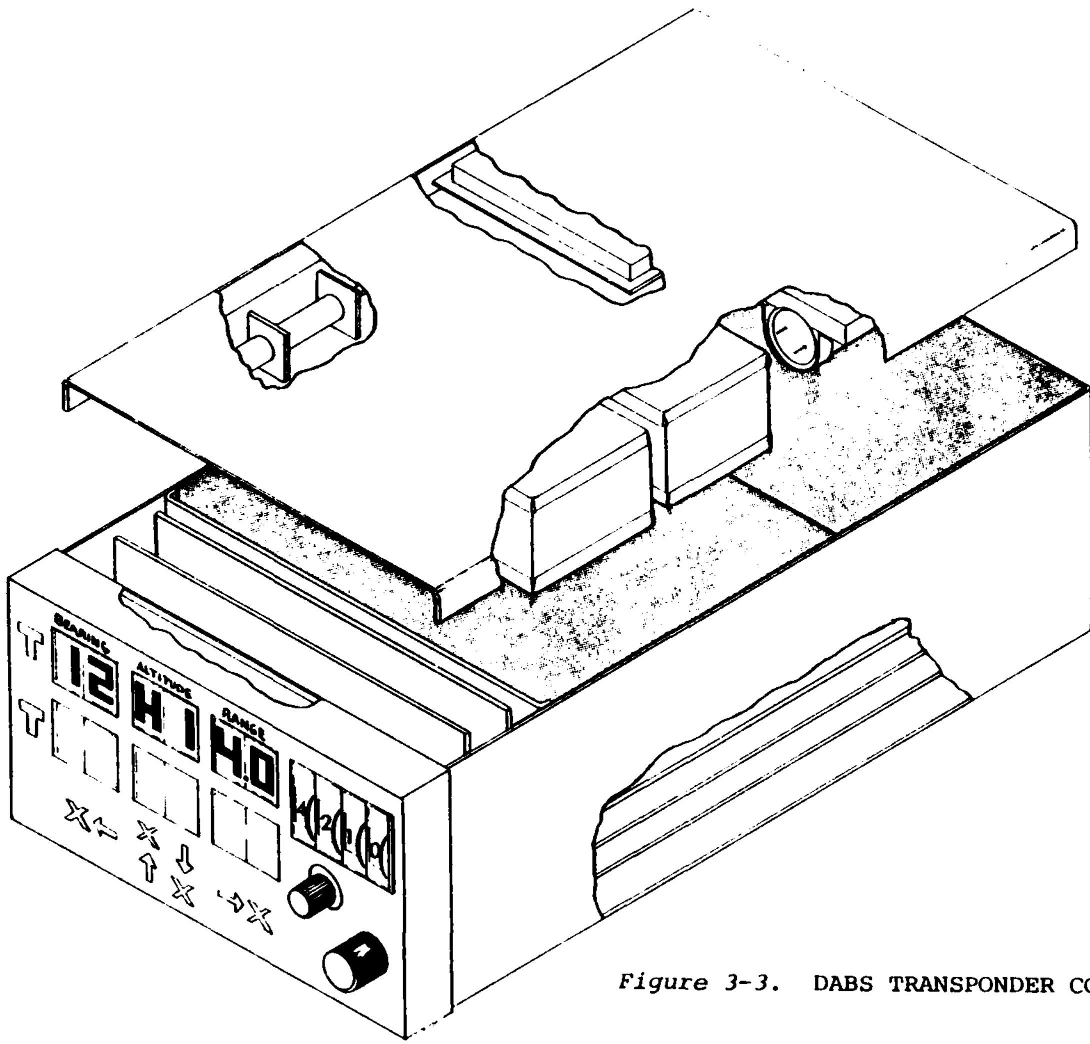

Figure 3-3. DABS TRANSPONDER CONFIGURATION WITH ATARS

The ATARS logic, as proposed, will be packaged on a separate PC board that contains the decoder for advisory information transferred from the DABS decoders after parity check and the display driver logic necessary for illustrating and holding advisory messages. In addition, the PC board would include the resolution advisory register (RAR) for transmission of displayed information to BCAS-equipped interrogators.

3.1.6 DABS with Comm A and B, ATARS, and BCAS Interface

The data link inherent in the DABS concept will permit communications between two BCAS-equipped aircraft, and provide BCAS activity control when the BCAS-equipped aircraft is within the range of a ground-based radar beacon transponder (RBX). The BCAS interface function incorporated in this configuration of the DABS transponder permits air-to-air communications over complementary frequencies of DABS and BCAS when uplink or downlink fields UF, DF=0, or 16 are detected. In addition, RBX transmissions for squitter or reply are received by the DABS receiver and forwarded to the BCAS processors when uplink fields (UF = 6,22) are detected. This interface capability is included in the ATARS functional module with connection between the two avionics equipments through the rear connectors. The design assumes very short cables between the BCAS and DABS units, permitting transfer of digital data without degradation.

3.1.7 DABS with Comm A and B and Uplink ELM (Comm C)

The extended length message format allows up to 16 segments of data to be transmitted over the Comm C data link. Since each segment can be sent in any order chosen by the ground, all segments must be retained in memory within the DABS transponder before being forwarded to an external display device. The addition of the uplink ELM to the transponder requires a microprocessor with peripherals to handle the communications. All other functions are the same as those described in Section 3.1.4. The logic required for Comm C operation will be added to the decoding boards. With discrete logic this will result in a total of three printed circuit boards measuring 6 x 6 inches, which are mounted horizontally in the transponder enclosure. The ELM data will be brought out at the rear connector for processing in other avionics.

3.1.8 DABS with Comm A and B, ATARS, and Comm C

Reintroduction of the ATARS information to the system described in Section 3.1.7 results in the configuration discussed here. All uplink data capabilities of DABS are considered, with required processing being performed within the transponder. Traffic and resolution advisory displays are integrated into the transponder enclosure while Comm C and portions of Comm A information are routed to external processors for display. The package for this configuration is similar to that shown in Figure 3-2, but it requires some additional unit length.

3.1.9 DABS with Comm A and B and Comm C and D

Comm D provides for the downlink transmission of ELM data. Data structure is similar to that for Comm C, requiring up to 16 segments of 112-bit messages. The entire message is stored in the transponder data buffers and transmitted, at ground command, by the number of the segments the ground directs. Provisions exist for repetition of any segment at ground's instructions, and data are not cleared until the system is so instructed by the ground segment. Because of the extended length of Comm D transmissions, the duty cycle on the airborne transmitter is higher than is available from cavity oscillators used in modern ATCRBS equipment. It is believed that solid-state amplifiers will be required to provide the temperature control necessary for the higher duty cycles resulting in changes to the modulator, final amplifier, and power supplies of the DABS transponder. The configuration discussed here assumes a power amplifier package rated for 18.5 dBW output at the antenna. A modulator would convert the digital data to a pulsed position input into a preamplifier, which could drive the amplifier package at about 150 watts peak for transmission. Since amplifiers can be designed at resonant frequencies without the need for crystal oscillator control, the unit would operate virtually the same as a cavity oscillator but with the capability for a much greater duty cycle. The power supply would require dc/dc transformation to permit 50 V operation from 14 V aircraft power and extensive storage capacity for the specified transmission of up to 16 consecutive 112-bit segments. Packaging for discrete components can still be accommodated in a 3.5 × 6.25 inch panel-mounted enclosure, although the requirement to dissipate heat could become a serious problem. This analysis does not consider the heat problem and therefore limits the panel size to that indicated. The transponder, as in Comm C configuration, acts as the storage and forward medium for Comm C and D messages, generating the overhead and parity functions. All additional processing of data is accomplished in external avionics.

3.1.10 Large Scale Integration (LSI)

Present trends in avionics designs indicate that many manufacturers are taking advantage of the benefits in packaging and cost associated with the use of custom large scale integration. Where there is a large enough market for a particular type of avionics, the manufacturers are developing LSI chips to reduce assembly labor costs and packaging size, and to improve the reliability of the avionics. All the DABS configurations considered in this study have been designed with discrete logic to permit function sectionalization for adaptation to LSI technology. From a review of each configuration, the number of LSIs was estimated on the basis of densities, pinouts, and power disipation requirements, and an equivalent LSI version of the DABS transponder was developed.

The engineering department of King Radio provided a simple procedure for estimating the number of LSI devices necessary to perform the functions of discrete small scale integration (SSI) and medium scale integration (MSI) associated with any design. This procedure, applied to the detailed design

drawings developed for each configuration, consists of the following considerations:

- An inverter can be implemented with one transistor on an LSI chip.
- Two input gates can be implemented with three transistors: two for each input and one for the output.
- A typical transistor can be implemented with 10 square mils of area. This is an estimate of a reasonably "tight" chip, but the estimate includes allowances for proper heat dissipation, routing paths, and buffer circuits.
- An LSI chip 200 mils on a side will provide approximately a 30 percent yield; this was considered acceptable for the purpose of this analysis. The chip size used provides an available area of 40,000 square mils.

In estimating the requirements of the function detailed on the design drawings, consideration was given to the practicability of including components that would unnecessarily burden an LSI in pinout or power dissipation. Integrated circuits (ICs) such as read-only memories (ROMs) and drivers for light emitting diodes (LEDs) were not included in the LSI but treated as separate devices in the configurations. Additional design changes were made to minimize pinout requirements. These included serialization of data for single pin input with later conversion to parallel form within the LSI chip. Finally, each integrated circuit was sized according to the number of one- and two-input gates necessary to perform its function, and this information was translated into the total number of transistors needed. With each transistor requiring 10 square mils the number of LSIs required for any of the DABS configurations could be estimated.

3.2 DEVELOPMENT OF TRANSPONDER COSTS

The cost of each transponder configuration identified in Section 3.1 was developed using traditional accounting methods. These methods require detailed parts identification for the production of modules, subassemblies, and systems. Each component was priced on the basis of OEM price lists for quantities necessary for production assemblies, with typical annual system production in the range of from one to three thousand units. A material handling charge of ten percent was added to the cost of materials to allow for inventory control, pre-testing, expected yield, and in-plant distribution. Calculations for assembly labor for each component were based on the nature of the component (i.e., two-lead devices, three-lead devices, etc.) using semiautomated insertion process. Labor rate is derived from Department of Labor statistics for the electronic industry, geographically corrected, and limited to the class of manufacturing for the general aviation community. A 1980 labor rate of $5.60 per hour was assumed typical for the expected manufacturers of low-performance general aviation aircraft avionics. Since the labor rate used is direct hourly wage, a 135 percent overhead burden was applied to the labor costs to cover typical overhead expenses. The sum of the material and labor costs provides the direct

production cost of a module or the system. A 20 percent general and administrative (GA) charge and an expected 15 percent profit are included in determining the factory selling price of the unit. Since typical production practice is to manufacturer transponders in subassemblies, the complete system must be assembled and tested prior to release for sale. To account for this activity and expense, an "Assembly and Test" cost column is included in each cost analysis. The same markups and rates are used in this cost development, except that there are no material costs associated with the activity.

The standard distributor markup of 100 percent has been applied to identify the advertized "list price" of the system. This markup covers distribution costs, inventory management of the distributors, and warranties beyond those provided by the original manufacturers.

The following sections present the results of applying this cost estimating method to each configuration of DABS presented in Section 3.1. Detailed parts lists associated with each configuration are included in Appendix A. The LSI equivalent transponder is presented in each configuration following the discrete version to facilitate cost comparison. Each configuration, discrete and LSI, required one stub antenna (two for diversity) at a list price of $19 added to the equipment cost to arrive at the system cost. This addition is considered in the life-cycle analyses presented in subsequent chapters.

3.2.1 Baseline DABS

The baseline transponder cost development is presented in Table 3-1 for the discrete version and in Table 3-2 for the LSI version. Both versions use the same IF amplifier module, modulator-demodulator module, and power supply modules. Decoding and encoding functions for the discrete version have been developed as a unit and then divided evenly for packaging on two printed circuit cards. The method for determining the number and size of cards was to allow one square inch of board space for each two ICs required. Since this version contains 150 ICs, and the useable panel width limits the PC card to six inches, with a practical depth limit the 75 square inches of area required to mount the ICs will be provided by two cards of 6 x 8 inches each. The extra space can be used to simplify printed circuit configuration. The equivalent LSI configuration requires four LSIs and 27 discrete integrated circuits. With the assumption that each 40-pin LSI requires two square inches of board space, the entire decode and encode function can be mounted on a single PC board not larger than 6 X 4 inches.

The costs for the enclosure and chassis, as well as those for the assembly and test, are almost the same for the two versions since there is very little difference between them. The minor material reduction for the sheet metal enclosure for the LSI version is not considered; the cost variation is the result of fewer connectors and less cabling for the LSI unit.

Table 3-1. COST OF BASELINE DABS (DISCRETE VERSION)

Cost Element	Module Cost in Dollars							
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	19.89	79.49	79.49	90.80	--	328.27
Material Handling (10 percent of material cost)	4.43	1.44	1.99	7.95	7.95	9.08	--	32.83
Labor ($5.60 per hour)	13.81	7.35	9.18	16.48	16.48	17.68	14.28	95.27
Burden (135 percent of labor cost)	18.64	9.92	12.39	22.24	22.24	23.87	19.28	128.58
Subtotal	81.13	33.06	43.45	126.16	126.16	141.43	33.56	584.95
G&A (20 percent of subtotal)	16.23	6.61	8.69	25.23	25.23	28.29	6.71	116.99
Total Direct Cost	97.36	39.67	52.14	151.39	151.39	169.72	40.27	701.94
Profit (15 percent of direct cost)	14.60	5.95	7.82	22.71	22.71	25.46	6.04	105.29
Factory Sell Price	111.96	45.62	59.96	174.10	174.10	195.18	46.31	807.23
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	807.23
List Price	--	--	--	--	--	--	--	1,614.46

Table 3-2. COST OF BASELINE DABS (LSI VERSION)

Cost Element	Module Cost in Dollars						
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	19.89	73.52	89.54	--	241.55
Material Handling (10 percent of material cost)	4.43	1.44	1.99	7.35	8.95	--	24.16
Labor ($5.60 per hour)	13.81	7.35	9.18	15.96	17.60	14.14	78.04
Burden (135 percent of labor cost)	18.64	9.92	12.39	21.55	23.76	19.09	105.35
Subtotal	81.13	33.06	43.45	118.38	139.85	33.23	449.10
G&A (20 percent of subtotal)	16.23	6.61	8.69	23.68	27.97	6.65	89.83
Total Direct Cost	97.36	39.67	52.14	142.06	167.82	39.88	538.92
Profit (15 percent of direct cost)	14.60	5.95	7.82	21.31	25.17	5.98	80.84
Factory Sell Price	111.96	45.62	59.96	163.37	192.99	45.86	619.76
Distribution (100 percent of factory price)	--	--	--	--	--	--	619.76
List Price	--	--	--	--	--	--	1,239.52

The pronounced cost difference in list price of $375 ($1614 for discrete and $1239 for LSI) is accounted for in the reduced material cost and assembly labor associated with the logic processing using LSI technology. These costs, however, do not include the development cost of the four LSIs which may have to be amortized over a specific production quantity.

3.2.2 Baseline DABS with Antenna Diversity

Antenna diversity affects the receiver, modulator, and transmitter functions of the transponder. The diversity switch, included in the expanded demodulator-modulator subassembly, provides the decision for antenna selection and control of output transmitters. Tables 3-3 and 3-4 present the cost development of this configuration in the discrete and LSI versions. Since large scale integration has not been applied to the antenna diversity configuration with the exception of the processor card, all changes to the baseline configuration affected both versions identically. Two IF amplifiers will be required, preceded by low-pass filters and preselectors. A single DPSK demodulator shares the PC board that houses the diversity switch with logic control and dual modulators. The additional cavity oscillator required for diversity operation is included in the enclosure and chassis module. The list prices of $2054 and $1679 for discrete and LSI versions respectively maintain the $375 difference shown for the baseline case.

3.2.3 Baseline DABS with 21.5 dBW at Antenna

Increasing power output to 21.5 dBW over the minimum 18.5 dBW specified in the DABS Draft National Standard is within the basic capability of the cavity oscillators used. The increase is the result of the additional storage capacity required in the power supplies of the transponder to provide a maximum 23.5 dBW power output. Tables 3-5 and 3-6 present the cost development for this configuration for the discrete and LSI versions.

3.2.4 DABS with Comm A and Comm B

The introduction of the 112-bit data field associated with Comm A and Comm B operation has a minor cost impact on the processing logic of DABS transponders. The total discrete chip count increases only from 150 to 156 ICs, not enough to change packaging considerations from those used for the baseline system. The LSI version would require four LSIs plus 30 discrete ICs. The three additional ICs are in the SSI and MSI category, but do not require more mounting surface than conventional ICs. The LSIs are customized for the Comm A and B application, and cannot be considered as the same as those developed for the baseline case. Table 3-7 presents the cost development for the discrete version, while Table 3-8 presents the cost development for the LSI version. Since additional communication capability does not affect analog signal processing, the remaining subassemblies are virtually the same as in the baseline case. Additional storage capacity for extended data transmission is included in the power supplies.

(Text continues on page 3-22.)

Table 3-3. COST OF BASELINE DABS WITH ANTENNA DIVERSITY (DISCRETE VERSION)

Cost Element	Module Cost in Dollars								
	IF Amplifier	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	44.25	27.46	19.89	79.49	79.49	133.79	--	428.62
Material Handling (10 percent of material cost)	4.43	4.43	2.75	1.99	7.95	7.95	13.38	--	42.86
Labor ($5.60 per hour)	13.81	13.81	10.46	9.18	16.48	16.48	19.53	16.38	116.13
Burden (135 percent of labor cost)	18.64	18.64	14.12	12.39	22.24	22.24	26.37	22.11	156.77
Subtotal	81.13	81.13	54.79	43.45	126.16	126.16	193.07	38.49	744.38
G&A (20 percent of Subtotal)	16.23	16.23	10.96	8.69	25.23	25.23	38.61	7.70	148.87
Total Direct Cost	97.36	97.36	65.75	52.14	151.39	151.39	231.68	46.19	893.25
Profit (15 percent of direct cost)	14.60	14.60	9.86	7.82	22.71	22.71	34.75	6.93	133.99
Factory Sell Price	111.96	111.96	75.61	59.96	174.10	174.10	266.43	53.12	1,027.24
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	--	1,027.24
List Price	--	--	--	--	--	--	--	--	2,054.48

Table 3-4. COST OF BASELINE DABS WITH ANTENNA DIVERSITY (LSI VERSION)

Cost Element	Module Cost in Dollars							
	IF Amplifier	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	44.25	27.46	19.89	73.52	132.53	--	341.90
Material Handling (10 percent of material cost)	4.43	4.43	2.75	1.99	7.35	13.25	--	34.19
Labor ($5.60 per hour)	13.81	13.81	10.46	9.18	15.96	19.44	16.24	98.90
Burden (135 percent of labor cost)	18.64	18.64	14.12	12.39	21.55	26.25	21.92	133.52
Subtotal	81.13	81.13	54.79	43.45	118.38	191.47	38.16	608.51
G&A (20 percent of subtotal)	16.23	16.23	10.96	8.69	23.68	38.29	7.63	121.70
Total Direct Cost	97.36	97.36	65.75	52.14	142.06	229.76	45.79	730.21
Profit (15 percent of direct cost)	14.60	14.60	9.86	7.82	21.31	34.46	6.87	109.53
Factory Sell Price	111.96	111.96	75.61	59.96	163.37	264.22	52.66	839.74
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	839.74
List Price	--	--	--	--	--	--	--	1,679.48

Table 3-5. COST OF BASELINE DABS WITH 21.5 dBW AT ANTENNA (DISCRETE VERSION)

Cost Element	Module Cost in Dollars							
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	20.73	79.49	79.49	90.80	--	329.11
Material Handling (10 percent of material cost)	4.43	1.44	2.07	7.95	7.95	9.08	--	32.91
Labor ($5.60 per hour)	13.81	7.35	9.23	16.48	16.48	17.68	14.28	95.32
Burden (135 percent of labor cost)	18.64	9.92	12.46	22.24	22.24	23.87	19.28	128.65
Subtotal	81.13	33.06	44.49	126.16	126.16	141.43	33.56	585.99
G&A (20 percent of subtotal)	16.23	6.61	8.90	25.23	25.23	28.29	6.71	117.20
Total Direct Cost	97.36	39.67	53.39	151.39	151.39	169.72	40.27	703.19
Profit (15 percent of direct cost)	14.60	5.95	8.01	22.71	22.71	25.46	6.04	105.48
Factory Sell Price	111.96	45.62	61.40	174.10	174.10	195.18	46.31	808.67
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	808.67
List Price	--	--	--	--	--	--	--	1,617.34

Table 3-6. COST OF BASELINE DABS WITH 21.5 dBW AT ANTENNA (LSI VERSION)

Cost Element	Module Cost in Dollars						
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	20.73	73.52	89.54	--	242.39
Material Handling (10 percent of material cost)	4.43	1.44	2.07	7.35	8.95	--	24.24
Labor ($5.60 per hour)	13.81	7.35	9.23	15.96	17.60	14.14	78.09
Burden (135 percent of labor cost)	18.64	9.92	12.46	21.55	23.76	19.09	105.42
Subtotal	81.13	33.06	44.49	118.38	139.85	33.23	450.14
G&A (20 percent of subtotal)	16.23	6.61	8.90	23.68	27.97	6.65	90.03
Total Direct Cost	97.36	39.67	53.39	142.06	167.82	39.88	540.17
Profit (15 percent of direct cost)	14.60	5.95	8.01	21.31	25.17	5.98	81.03
Factory Sell Price	111.96	45.62	61.40	163.37	192.99	45.86	621.20
Distribution (100 percent of factory price)	--	--	--	--	--	--	621.20
List Price	--	--	--	--	--	--	1,242.40

Table 3-7. COST OF BASELINE DABS WITH COMM A AND B (DISCRETE VERSION)

Cost Element	Module Cost in Dollars							
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	85.15	85.15	90.80	--	342.11
Material Handling (10 percent of material cost)	4.43	1.44	2.24	8.52	8.52	9.08	--	34.21
Labor ($5.60 per hour)	13.81	7.35	9.31	16.91	16.91	17.68	14.28	96.25
Burden (135 percent of labor cost)	18.64	9.92	12.57	22.83	22.83	23.87	19.28	129.95
Subtotal	81.13	33.06	46.53	133.41	133.41	141.43	33.56	602.53
G&A (20 percent of subtotal)	16.23	6.61	9.31	26.68	26.68	28.29	6.71	120.50
Total Direct Cost	97.36	39.67	55.84	160.09	160.09	169.72	40.27	723.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	24.01	24.01	25.46	6.04	108.46
Factory Sell Price	111.96	45.62	64.22	184.10	184.10	195.18	46.31	831.49
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	831.49
List Price	--	--	--	--	--	--	--	1,662.98

Table 3-8. COST OF BASELINE DABS WITH COMM A AND B (LSI VERSION)

Cost Element	Module Cost in Dollars						
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	87.65	89.54	--	258.20
Material Handling (10 percent of material cost)	4.43	1.44	2.24	8.77	8.95	--	25.82
Labor ($5.60 per hour)	13.81	7.35	9.31	16.23	17.60	14.14	78.44
Burden (135 percent of labor cost)	18.64	9.92	12.57	21.91	23.76	19.09	105.90
Subtotal	81.13	33.06	46.53	134.56	139.85	33.23	468.36
G&A (20 percent of subtotal)	16.23	6.61	9.31	26.91	27.97	6.65	93.67
Total Direct Cost	97.36	39.67	55.84	161.47	167.82	39.88	562.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	24.22	25.17	5.98	84.31
Factory Sell Price	111.96	45.62	64.22	185.69	192.99	45.86	646.34
Distribution (100 percent of factory price)	--	--	--	--	--	--	646.34
List Price	--	--	--	--	--	--	1,292.68

3.2.5 DABS with Comm A and B and ATARS

The cost of introducing ATARS can be identified in the cost of development of the two ATARS boards. As for the decode-encode cards, the ATARS components were identified from the detailed design, costs for materials and assembly labor were estimated, and the costs were divided equally to establish the cost of each card. These cards are expected to measure 6 x 3.25 inches each and will be mounted vertically directly behind the front panel. The ATARS function requires 73 discrete integrated circuits. Alpha-numeric displays and command advisory LEDs are included in the cost of the cards but will be mounted in the front panel. Table 3-9 presents the cost development of the discrete version of this configuration; Table 3-10 presents the comparable cost development of the LSI version. The ATARS functions are integrated into the main processing board, resulting in a PC board that has five LSIs and 55 discrete integrated circuits. The 25 additional ICs required for ATARS are used primarily as drivers of the LED displays and normal interface between the LSIs and displays.

3.2.6 DABS with Comm A and B, ATARS, and BCAS Interface

The expansion of the processing functions by addition of the BCAS interface required repackaging of the encoder-decoder logic boards. The 187 chips required to process all the logic, not including ATARS, exceed the capacity of two boards sized for a modern transponder. Therefore three boards have been proposed. The cost development summary is presented in Table 3-11. The LSI version, however, is not affected in material cost because the BCAS interface functions can be incorporated into the custom LSI design without exceeding the density criteria of each LSI. Table 3-12 presents the cost development of this configuration. It is identical to the cost of the DABS with ATARS, although the LSIs are different in design.

3.2.7 DABS with Comm A and B and Uplink ELM (Comm C)

The ELM function can best be processed using modern microcomputers with appropriate memory devices. Table 3-13 presents the cost development of this DABS configuration in the discrete version. The LSI version is shown in Table 3-14. The same microcomputer is used in this version since incorporating the ELM function in a custom LSI is not considered cost effective. All components in this configuration are MSIs or LSIs already.

3.2.8 DABS with Comm A and B, ATARS, and Comm C

The transponder with complete uplink data capability, including the traffic advisory information of ATARS, results in a unit that would have a list price of $2261 for the discrete version of logic and a list price of $1719 for the LSI version. The costs for the two versions are presented in Tables 3-15 and 3-16. The ATARS function is designed for separate printed circuit-board configuration in the discrete version; it is an additional cost when added to the configuration of Section 3.2.7. However the LSI version requires a single large PC board, which includes all the data link and ATARS logic. This requires five custom LSIs and 58 discrete

(Text continues on page 3-33.)

Table 3-9. COST OF BASELINE DABS WITH COMM A AND B AND ATARS (DISCRETE VERSION)

Cost Element	Module Cost in Dollars									
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Decoder and Encoder Board I	Decoder and Encoder Board II	ATARS Board 1	ATARS Board 2	Enclosure and *Chassis*	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	85.15	85.15	52.34	52.34	86.46	--	442.45
Material Handling (10 percent of material cost)	4.43	1.44	2.24	8.52	8.52	5.23	5.23	8.65	--	44.25
Labor ($5.60 per hour)	13.81	7.35	9.31	16.91	16.91	10.27	10.27	12.48	18.34	115.65
Burden (135 percent of labor cost)	18.64	9.92	12.57	22.83	22.83	13.86	13.86	16.85	24.76	156.13
Subtotal	81.13	33.06	46.53	133.41	133.41	81.70	81.70	124.44	43.10	758.48
G&A (20 percent of subtotal)	16.23	6.61	9.31	26.68	26.68	16.34	16.34	24.89	8.62	151.70
Total Direct Cost	97.36	39.67	55.84	160.09	160.09	98.04	98.04	149.33	51.72	910.18
Profit (15 percent of direct cost)	14.60	5.95	8.38	24.01	24.01	14.71	14.71	22.40	7.76	136.53
Factory Sell Price	111.96	45.62	64.22	184.10	184.10	112.75	112.75	171.73	59.48	1,046.71
Distribution (100 percent of *factory price*)	--	--	--	--	--	--	--	--	--	1,046.71
List Price	--	--	--	--	--	--	--	--	--	2,093.42

Table 3-10. COST OF BASELINE DABS WITH COMM A AND B AND ATARS (LSI VERSION)

Cost Element	Module Cost in Dollars						
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	155.44	84.68	--	321.13
Material Handling (10 percent of material cost)	4.43	1.44	2.24	15.54	8.47	--	32.11
Labor ($5.60 per hour)	13.81	7.35	9.31	29.88	16.81	17.92	95.08
Burden (135 percent of labor cost)	18.64	9.92	12.57	40.34	22.70	24.19	128.37
Subtotal	81.13	33.06	46.53	241.20	132.66	42.11	576.69
G&A (20 percent of subtotal)	16.23	6.61	9.31	48.24	26.53	8.42	115.34
Total Direct Cost	97.36	39.67	55.84	289.44	159.19	50.53	692.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	43.42	23.88	7.58	103.81
Factory Sell Price	111.96	45.62	64.22	332.86	183.07	58.11	795.84
Distribution (100 percent of factory price)	--	--	--	--	--	--	795.84
List Price	--	--	--	--	--	--	1,591.68

Table 3-11. COST OF BASELINE DABS WITH COMM A AND B, ATARS, AND BCAS INTERFACE (DISCRETE VERSION)

Cost Element	Module Cost in Dollars										
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Logic Board I	Logic Board II	Logic Board III	ATARS Board 1	ATARS Board 2	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	59.54	59.54	59.54	52.34	52.34	87.72	--	452.03
Material Handling (10 percent of material cost)	4.43	1.44	2.24	5.95	5.95	5.95	5.23	5.23	8.77	--	45.20
Labor ($5.60 per hour)	13.81	7.35	9.31	13.47	13.47	13.47	10.27	10.27	12.57	18.48	122.46
Burden (135 percent of labor cost)	18.64	9.92	12.57	18.18	18.18	18.18	13.86	13.86	16.96	24.95	165.30
Subtotal	81.13	33.06	46.53	97.14	97.14	97.14	81.70	81.70	126.02	43.43	784.99
G&A (20 percent of subtotal)	16.23	6.61	9.31	19.43	19.43	19.43	16.34	16.34	25.20	8.69	157.01
Total Direct Cost	97.36	39.67	55.84	116.57	116.57	116.57	98.04	98.04	151.22	52.12	942.00
Profit (15 percent of direct cost)	14.60	5.95	8.38	17.49	17.49	17.49	14.71	14.71	22.68	7.82	141.32
Factory Sell Price	111.96	45.62	64.22	134.06	134.06	134.06	112.75	112.75	173.80	59.94	1,083.32
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	--	--	--	1,083.32
List Price	--	--	--	--	--	--	--	--	--	--	2,166.64

Table 3-12. COST OF BASELINE DABS WITH COMM A AND B AND ATARS AND BCAS INTERFACE (LSI VERSION)

Cost Element	Module Cost in Dollars						
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	155.44	84.68	--	321.13
Material Handling (10 percent of material cost)	4.43	1.44	2.24	15.54	8.47	--	32.11
Labor ($5.60 per hour)	13.81	7.35	9.31	29.88	16.81	17.92	95.08
Burden (135 percent of labor cost)	18.64	9.92	12.57	40.34	22.70	24.19	128.37
Subtotal	81.13	33.06	46.53	241.20	132.66	42.11	576.69
G&A (20 percent of subtotal)	16.23	6.61	9.31	48.24	26.53	8.42	115.34
Total Direct Cost	97.36	39.67	55.84	289.44	159.19	50.53	692.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	43.42	23.88	7.58	103.81
Factory Sell Price	111.96	45.62	64.22	332.86	183.07	58.11	795.84
Distribution (100 percent of factory price)	--	--	--	--	--	--	795.84
List Price	--	--	--	--	--	--	1,591.68

Table 3-13. COST OF BASELINE DABS WITH COMM A AND B AND ELM UPLINK (DISCRETE VERSION)

Cost Element	Module Cost in Dollars								
	IF Amplifier	DPSK Demod and Modulator	Power Supply	IF Logic Amplifier	DPSK Demod Logic Modulator	Power Logic Supply	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	64.26	64.26	64.26	92.06	--	365.85
Material Handling (10 percent of material cost)	4.43	1.44	2.24	6.43	6.43	6.43	9.21	--	36.59
Labor ($5.60 per hour)	13.81	7.35	9.31	14.24	14.24	14.24	17.76	20.02	110.97
Burden (135 percent of labor cost)	18.64	9.92	12.57	19.22	19.22	19.22	23.98	27.02	149.82
Subtotal	81.13	33.06	46.53	104.15	104.15	104.15	143.01	47.04	663.23
G&A (20 percent of subtotal)	16.23	6.61	9.31	20.83	20.83	20.83	28.60	9.41	132.64
Total Direct Cost	97.36	39.67	55.84	124.98	124.98	124.98	171.61	56.45	795.87
Profit (15 percent of direct cost)	14.60	5.95	8.38	18.75	18.75	18.75	25.74	8.47	119.38
Factory Sell Price	111.96	45.62	64.22	143.72	143.72	143.72	197.35	64.92	915.25
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	--	915.25
List Price	--	--	--	--	--	--	--	--	1,830.50

Table 3-14. COST OF BASELINE DABS WITH COMM A AND B AND ELM UPLINK (LSI VERSION)

Cost Element	Module Cost in Dollars						
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	112.42	89.54	---	282.97
Material Handling (10 percent of material cost)	4.43	1.44	2.24	11.24	8.95	---	28.30
Labor ($5.60 per hour)	13.81	7.35	9.31	17.62	17.60	19.74	85.43
Burden (135 percent of labor cost)	18.64	9.92	12.57	23.78	23.76	26.65	115.32
Subtotal	81.13	33.06	46.53	165.06	139.85	46.39	512.02
G&A (20 percent of subtotal)	16.23	6.61	9.31	33.01	27.97	9.28	102.41
Total Direct Cost	97.36	39.67	55.84	198.07	167.82	55.67	614.43
Profit (15 percent of direct cost)	14.60	5.95	8.38	29.71	25.17	8.35	92.16
Factory Sell Price	111.96	45.62	64.22	227.78	192.99	64.02	706.59
Distribution (100 percent of factory price)	--	--	--	--	--	--	706.59
List Price	--	--	--	--	--	--	1,413.18

Table 3-15. COST OF BASELINE DABS WITH COMM A AND B, ATARS, AND ELM UPLINK (DISCRETE VERSION)

Cost Element	Module Cost in Dollars									
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Processor	Processor	Processor	ATARS Board 1	ATARS Board 2	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.23	22.41	64.26	64.26	64.26	52.34	52.34	87.72	---	466.19
Material Handling (10 percent of material cost)	4.43	1.44	2.24	6.43	6.43	6.43	5.23	5.23	8.77	---	46.62
Labor ($5.60 per hour)	13.81	7.35	9.31	14.24	14.24	14.24	10.27	10.27	12.57	24.08	130.38
Burden (135 percent of labor cost)	18.64	9.92	12.57	19.22	19.22	19.22	13.86	13.86	16.96	32.51	176.00
Subtotal	81.13	33.06	46.53	104.15	104.15	104.15	81.70	81.70	126.02	56.59	819.19
G&A (20 percent of subtotal)	16.23	6.61	9.31	20.83	20.83	20.83	16.34	16.34	25.20	11.32	163.84
Total Direct Cost	97.36	39.67	55.84	124.98	124.98	124.98	98.04	98.04	151.22	67.91	983.03
Profit (15 percent of direct cost)	14.60	5.95	8.38	18.75	18.75	18.75	14.71	14.71	22.68	10.19	147.46
Factory Sell Price	111.96	45.62	64.22	143.72	143.72	143.72	112.75	112.75	173.90	78.10	1,130.46
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	--	--	--	1,130.46
List Price	--	--	--	--	--	--	--	--	--	--	2,260.92

Table 3-16. COST OF BASELINE DABS WITH COMM A AND B, ATARS, AND ELM UPLINK (LSI VERSION)

Cost Element	Module Cost in Dollars						
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	22.41	179.21	84.68	--	344.90
Material Handling (10 percent of material cost)	4.43	1.44	2.24	17.92	8.47	--	34.49
Labor ($5.60 per hour)	13.81	7.35	9.31	32.78	16.81	23.52	103.58
Burden (135 percent of labor cost)	18.64	9.92	12.57	44.26	22.70	31.75	139.85
Subtotal	81.13	33.06	46.53	274.17	132.66	55.27	622.82
G&A (20 percent of subtotal)	16.23	6.61	9.31	54.83	26.53	11.05	124.57
Total Direct Cost	97.36	39.67	55.84	329.00	159.19	66.32	747.39
Profit (15 percent of direct cost)	14.60	5.95	8.38	49.35	23.88	9.95	112.10
Factory Sell Price	111.96	45.62	64.22	378.35	183.07	76.27	859.49
Distribution (100 percent of factory price)	--	--	--	--	--	--	859.49
List Price	--	--	--	--	--	--	1,718.98

Table 3-17. COST OF DABS WITH COMM A AND B AND COMM C AND D (DISCRETE VERSION)

Cost Element	Module Cost in Dollars									
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Processor	Processor	Processor	Power Amplifier	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	23.30	71.39	71.39	71.39	117.47	62.06	--	475.60
Material Handling (10 percent of material cost)	4.43	1.44	2.33	7.14	7.14	7.14	11.75	6.21	--	47.56
Labor ($5.60 per hour)	13.81	7.35	9.54	14.76	14.76	14.76	9.14	16.50	20.16	120.78
Burden (135 percent of labor cost)	18.64	9.92	12.88	19.93	19.93	19.93	12.35	22.28	27.22	163.10
Subtotal	81.13	33.06	48.05	113.22	113.22	113.22	150.71	107.05	47.38	807.04
G&A (20 percent of subtotal)	16.23	6.61	9.61	22.64	22.64	22.64	30.14	21.41	9.48	161.40
Total Direct Cost	97.36	39.67	57.66	135.86	135.86	135.86	180.85	128.46	56.86	968.44
Profit (15 percent of direct cost)	14.60	5.95	8.65	20.38	20.38	20.38	27.13	19.27	8.53	145.27
Factory Sell Price	111.96	45.62	66.31	156.24	156.24	156.24	207.98	147.73	65.39	1,113.71
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	--	--	1,113.71
List Price	--	--	--	--	--	--	--	--	--	2,227.42

Table 3-18. COST OF BASELINE DABS WITH COMM A AND B AND ELM UPLINK AND DOWNLINK (LSI VERSION)

Cost Element	Module Cost in Dollars							
	IF Amplifier	DPSK Demod and Modulator	Power Supply	Main PC Board	Power Amplifier	Enclosure and Chassis	Assembly and Test	Totals
Material Cost	44.25	14.35	23.30	124.39	117.47	59.54	--	383.30
Material Handling (10 percent of material cost)	4.43	1.44	2.23	12.44	11.75	5.95	--	38.33
Labor ($5.60 per hour)	13.81	7.35	9.54	18.36	9.14	16.33	20.72	95.25
Burden (135 percent of labor cost)	18.64	9.92	12.88	24.78	12.35	22.05	27.97	128.59
Subtotal	81.13	33.06	48.05	179.97	150.71	103.87	48.69	645.47
G&A (20 percent of subtotal)	16.23	6.61	9.61	35.99	30.14	20.77	9.74	129.09
Total Direct Cost	97.36	39.67	57.66	215.96	180.85	124.64	58.43	774.57
Profit (15 percent of direct cost)	14.60	5.95	8.65	32.39	27.13	18.70	8.76	116.18
Factory Sell Price	111.96	45.62	66.31	248.35	207.98	143.34	67.19	890.75
Distribution (100 percent of factory price)	--	--	--	--	--	--	--	890.75
List Price	--	--	--	--	--	--	--	1,781.50

Table 3-19. COST OF ATCRBS (DISCRETE VERSION)					
Cost Element	Module Cost in Dollars				
	Receiver	Main PC Board	Chassis	Assembly and Test	Total
Material Cost	26.79	49.37	69.72	--	145.88
Material Handling (10 percent of material cost)	2.68	4.94	6.97	--	14.59
Labor ($5.60 per hour)	11.45	11.83	8.51	10.64	42.43
Burden (135 percent of labor cost)	15.45	15.97	11.49	14.36	57.27
Subtotal	56.37	82.11	96.69	25.00	260.17
G&A (20 percent of subtotal)	11.27	16.42	19.34	5.00	52.03
Total Direct Cost	67.64	98.53	116.03	30.00	312.20
Profit (15 percent of direct cost)	10.15	14.78	17.40	4.50	46.83
Factory Sell Price	77.79	113.31	133.43	34.50	359.03
Distribution (100 percent of factory price)	--	--	--	--	359.03
List Price	--	--	--	--	718.06

ICs and integrates all functions. The front panel display requires 3.5 inches of height for either version, controlling one dimension of packaging requirements.

3.2.9 DABS with Comm A and B and Comm C and D

The high duty cycle associated with downlink ELM (Comm D) transmissions dictated the design and cost development of solid-state power amplifiers.

Table 3-17 presents the cost development of the discrete version of this DABS configuration; Table 3-18 presents the LSI version. Data processing in the discrete version is accomplished on three printed circuit boards using discrete ICs for most of the required functions and a microcomputer with one peripheral for the ELM functions. A total of 176 chips are required, including 1 in the microcomputer family, to provide the DABS capability for Comm A, B, C, and D. The equivalent LSI version can accomplish the functions with four LSIs, one microcomputer with one family chip, and 30 discrete ICs. The solid-state power amplifier and power supply modules are common to both versions and provide 18.5 dBW output power at the antenna terminals. The power is developed by using four chains of cascading microwave transistors with a final output of 150 watts at 50 volts. The cost of the transistors alone is $90. The list price of the amplifier is $416. This is considerably higher than the equivalent oscillator tube amplifier, which has a user replacement price of $178. However, the solid-state amplifier would be capable of transmitting 16 segments of Comm D data consecutively without exceeding the rated duty factor of the transistors. The power supply includes two large storage capacitors that provide the required 25,000 microfarads of energy without exceeding a 2-dB degradation in output power. Additional storage capacitors are included in the 28-volt and 50-volt stages of the power amplifier.

3.2.10 ATCRBS Transponder

The costs for the various DABS configurations were developed using a typical piece count pricing method. Since the cost factors used are typical of electronic manufacturers, their applicability to the avionics community can be challenged. The FAA requested us to use the same method on a typical modern ATCRBS transponder whose list price is nationally advertised to permit comparison of the results with advertised list prices. A modern transponder was chosen and evaluated by the piece part method. The detailed list of component parts used and assembly labor estimates are presented in Appendix A. Table 3-19 presents the cost development based on the ATCRBS material and labor estimates and the same cost factors used in DABS cost development. The resulting list price of $718 is quite close to the advertised price of $695. The difference can be attributed to a lower profit on transponders because of the intense competition in the sales of these popular avionics.

3.3 TRANSPONDER RELIABILITY

The reliability of each of the systems was reviewed and evaluated. The detailed parts lists developed for cost evaluation permitted application of the MIL-217C* reliability-prediction technique in the determination of system or module mean time between failure (MTBF) by component failure rate.

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*Military Standardization Handbook, *Reliability Stress and Failure Rate Data for Electronic Equipment*, MIL-HDBK-217C, 9 April 1979.

When the MIL-217C reliability-prediction technique is used, it is necessary to make assumptions regarding key system operating parameters. For example, the operating ambient temperature was chosen at 40° C. The stress ratio (ratio of operating value to maximum rated value) for components was assumed to be 0.5. Junction temperatures used were those listed in *D.A.T.A. Reference Standards for Industry*, as applicable to the semiconductor class. Critical transistors, e.g., modulators, were evaluated to establish the normalized junction temperature (T_n), and failure rates were derived from curves and data tables of MIL-217C. The environmental factor for airborne application was used for all calculations.

The reliability evaluations of the systems considered all electronic components in the circuits of the systems. A failure of any component was treated as causing a failure of the system.

The average material cost per repair action was developed by determining the contribution of any component to the module's reliability on the basis of that component's cost and expected failure rate.

The detailed development of these data is presented in Appendix A. The data are presented as failure rates per million hours of operation. The MTBF for any module can be calculated by application of the following formula:

$$\text{MTBF} = \frac{1 \times 10^6}{\text{Failure Rate}} \qquad (3\text{-}1)$$

System reliability can be determined by addition of all module failure rates and application of Equation 3-1. *Transponder MTBFs are shown in* Table 3-20.

3.4 SUMMARY OF TRANSPONDER COSTS

The costs developed in this chapter considered various configurations of DABS transponders with both discrete and LSI logic designs. Table 3-20 presents a summary of the costs developed for each configuration. Since each configuration is unique, requiring designs that optimize the data processing for that configuration, the difference between any sets of costs should not be considered as the expected cost of later adding the particular capability. For example the cost of adding ATARS capability to an existing DABS transponder with Comm A/B capability should not be expected to be only $430, the difference between the costs of installing DABS with and without ATARS. Rather the cost of the DABS with ATARS can be expected to be $2,093 if designed originally into the system, and the cost of DABS without ATARS would be only $1,663. Even though the acquisition cost of the LSI versions average 23 percent less than the discrete versions, the cost advantage for each design when LSI technology is introduced must be considered only after the development cost of LSIs is amortized during the early part of transponder introduction. The effect of amortization is considered in the life-cycle-cost analysis of subsequent chapters.

Table 3-20. TRANSPONDER RELIABILITY (MTBF IN HOURS)		
Transponder Configuration	Components	
	Discrete	LSI
ATCRBS	2,170	---
Basic Surveillance DABS	1,580	1,755
Basic DABS with Antenna Diversity	1,080	1,160
Basic DABS with 21.5 dBW at Antenna	1,580	1,755
DABS with Comm A and B	1,570	1,745
DABS with Comm A and B and ATARS	1,600	1,865
DABS with Comm A and B, ATARS, and BCAS Interface	1,575	1,865
DABS with Comm A, B, and C	1,740	1,990
DABS with Comm A, B, and C and ATARS	1,570	1,830
DABS with Comm A, B, C, and D	1,420	1,600

A study of Table 3-21 allows an evaluation of the comparative costs associated with designing a desired level of DABS capability.

Table 3-21. ACQUISITION COST OF TRANSPONDERS (CONSTANT 1980 DOLLARS)		
Transponder Configuration	Components	
	Discrete	LSI
ATCRBS	718	---
Basic Surveillance DABS	1,614	1,239
Basic DABS with Antenna Diversity	2,054	1,679
Basic DABS with 21.5 dBW at Antenna	1,617	1,242
DABS with Comm A and B	1,663	1,293
DABS with Comm A and B and ATARS	2,093	1,592
DABS with Comm A and B, ATARS, and BCAS Interface	2,167	1,592
DABS with Comm A, B, and C	1,830	1,413
DABS with Comm A, B, and C and ATARS	2,261	1,719
DABS with Comm A, B, C, and D	2,227	1,781

CHAPTER FOUR

LIFE-CYCLE-COST MODEL COMMON PARAMETERS

This chapter addresses the development of those data items that are treated in the economic analysis as being common to any DABS concept. They include the estimated installation costs of transponders and the population projections for the low-performance general aviation community.

4.1 COST OF DABS ELECTRONICS COMPONENTS

The equipments studied have been limited to the airborne elements of the DABS system. Chapter Three developed the cost of the various DABS configurations that may be implemented in the low-performance general aviation aircraft community. In all cases it was assumed that the DABS electronics would be integrated into a single package and that the installation would consist of the transponder, cables, and antenna. Since the DABS operates on the same frequencies as the present ATCRBS it was assumed that the aircraft would use the low-cost quarter-wavelength stub antenna.

4.2 AIRCRAFT CONFIGURATION

The complement of equipment to be installed by a user normally depends on individual needs, probable flight profiles, the reliabilities required to provide suitable aircraft availability, and the anticipated or required flight crews for special classes of aircraft. Since this study is limited to low-performance general aviation aircraft it is assumed that the aircraft owner will carry the minimum avionics consistent with flight regulations and safety. This assumed installation will consist of a single set of DABS electronics with the electronics being installed in the flight console of the aircraft. It has been assumed that retrofit systems will reuse existing ATCRBS antenna installations.

4.3 INSTALLATION COSTS

The cost of equipment installation considered in this study falls into two categories: (1) retrofit of the existing fleet, and (2) installation in new aircraft.

Low-performance general aviation aircraft retrofit cost data were developed by a survey of avionics maintenance facilities because the majority of low-performance general aviation aircraft are maintained at such facilities

throughout the country. In 1974 more than 500 maintenance facilities were surveyed to solicit information on the labor requirement to retrofit a NARCO DME-190 unit with an appropriate antenna in the low-performance class of aircraft. The results of this survey were published in Report No. FAA-EM-76-1. In 1979 ARINC Research interviewed a selected sample of the responding maintenance organizations and obtained their new labor rates for comparison with those furnished in 1974. The labor estimations obtained in 1974 were in hours and were still considered valid. These new labor and material costs were published in Report No. FAA-EM-79-14. We updated the labor and material cost from FAA-EM-79-14 by using a Bureau of Labor Statistics inflation factor of 9.23 percent to arrive at a new base labor rate of $25.25 per hour. Table 4-1 presents the expected labor and material cost of retrofitting avionics in the low-performance aircraft by using the 1980 labor rate and cost of materials.

Table 4-1. AVIONICS RETROFIT INSTALLATION COSTS FOR LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT

Cost Category	Single-Engine Aircraft		Twin-Engine Aircraft	
	Hours*	Cost (at $25.25 per hour)	Hours*	Cost (at $25.25 per hour)
Electronics	4.51	113.88	6.43	162.36
Antenna	2.32	58.58	3.21	81.05
Cabling	3.92	98.98	5.31	54.35
Material		40.43		54.35
Total Installation Cost		311.87		431.84

*Installation times are based on the mean of labor hours quoted by 125 facilities.

For purposes of this analysis we used a weighted average of $325 for a complete installation in the low-performance general aviation aircraft. We then assumed that the cost of antenna installation would be eliminated on the premise that the majority of general aviation aircraft are already equipped with ATCRBS transponders and the existing antenna would be reusable. This reduced the retrofit cost to $264. For aircraft that require an antenna installation the increased cost is offset (in the population average) by elimination of the cost to remove existing equipment and the reduction of unit installation cost because of space availability. We did include the cost of a new antenna in the acquisition costs because manufacturers normally include an antenna as part of the installation kit.

It was assumed that installation costs in new general aviation aircraft would be 60 percent of the estimated retrofit costs of $325 for a complete installation, or $195. For antenna diversity, the retrofit installation

cost would be $344 and the installation in a new aircraft would be $242. These costs include the extra antenna required.

4.4 AIRCRAFT SCENARIO

Installation of DABS in aircraft is assumed to begin in 1987. It is assumed that all new aircraft delivered in 1987 and in subsequent years would have DABS installed as part of the original required avionic equipment. The retrofit period for the low-performance general aviation community has been assumed for purposes of this study to be 14 years, with the number of retrofits being a linear function. It is assumed that 85 percent of the projected active aircraft population will be retrofitted with DABS by 2001, with the retrofit period beginning in 1987. The remaining 15 percent are assumed to be inactivated or to fall into the category of aircraft normally not equipped with transponders.

To develop an aircraft baseline for 1987 and project an expected installation schedule for DABS, we reviewed a number of documents. Among these were FAA-AVP-80-8 of September 1980, *FAA Aviation Forecasts FY 1981-1992;* FAA-AVP-79-9 of September 1979, *FAA Aviation Forecast FY 1980-1991;* FAA-AVP-78-11 of September 1978, *FAA Aviation Forecasts FY 1979-1990;* FAA-MS-79-5 of April 1979, *1977 General Aviation Activity and Avionics Survey;* FAA-MS-80-5 of March 1980, *1978 General Aviation and Avionics Survey; FAA Statistic Handbook of Aviation for 1978;* and the *World Aviation Directory*, Volumes No. 75 through No. 80. Our purpose was to balance projections with production quantities to determine an increment of new aircraft per year. Most forecasts deal only with actual total fleet increases per year without separate categories for new aircraft per year and aircraft lost to attrition each year. Table 4-2 presents the baseline category for 1 January 1979. We chose this date because of the data agreement between FAA-MS-80-5 and FAA-AVP-80-8 on that date. Table 4-2 shows not only the baseline year but the projected change in active aircraft population by year. The extensive data base available in FAA-MS-79-5 and FAA-MS-80-5 allowed the determination that approximately 17 percent of the multi-engine piston aircraft were in the high-performance category. Combining this percentage with the assumed 10 percent of multi-engine aircraft in the high-performance category taken from FAA-EM-76-1, *Cost Analysis of Airborne Collision Avoidance Systems (CAS)* concepts, we projected that approximately 28 percent of the multi-engine piston aircraft would be in the high-performance category in 1987.

The data from Table 4-2 were combined with data from FAA-AVP-80-8 to project the expected active aircraft population in Table 4-3. Table 4-3 combines all low-performance aircraft types into one category and weighs the statistics of Table 4-2 to project a statistical data base for 1 January 1987.

The average flight hours per year per aircraft is a weighted average of all aircraft in a category. Table 4-3 forms the basis of aircraft-particular parameters such as quantities, flight hours, and production schedules for the airborne portion of the LCC study. It is based on current aircraft production rates, aircraft exports, and FAA projections.

Table 4-2. BASELINE AIRCRAFT DATA FOR LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT (AS OF JANUARY 1979)

Aircraft Categories	Single-Engine	Multi-Engine	Rotorcraft
Active Aircraft	160,651	19,232	5,315
Average Flight Hours per Year	172	266	422
Projected New Aircraft per Year	10,900	1,500	450

Table 4-3. LIFE-CYCLE-COST BASELINE DATA FOR LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT

Aircraft Category	Quantity
Statistical Data as of 1 January 1979	
Active Aircraft	185,200
New Aircraft Added per Year	12,850
Approximate Fleet Increase per Year	7,520
Statistical Data as of 1 January 1987	
Projected Active Aircraft	245,360
Average Flight Hours per Year per Aircraft	189
Projected Average Number of Transponders Installed in New Aircraft per Year	12,850
Projected Average Transponders Retrofitted per Year	14,900

4.5 MAINTENANCE SCENARIO

The maintenance scenario used in the life-cycle-cost model considers two levels of repair: on-aircraft and off-aircraft maintenance. On-aircraft

maintenance consists of simple removal and replacement of failed units. Off-aircraft maintenance encompasses all other maintenance actions required in the event of an equipment failure.

4.5.1 On-Aircraft Maintenance

On-aircraft maintenance is limited to the cost of removing and replacing failed units. Preventive maintenance was not considered because the general aviation user community does not generally provide preventive maintenance for transponders.

Remove and replace actions are initiated when an aircraft lands at a repair facility and reports a transponder failure. The cost incurred is for the time required to complete the maintenance action charged on an hourly basis. For the purposes of this analysis, the time required was assumed to be 1.5 hours, broken down as follows:

- 15 minutes for the maintenance person to get to the aircraft
- 15 minutes to remove the failed unit
- 15 minutes to take the failed unit back to the shop for testing and repair or replacement
- 15 minutes to return to the aircraft with the repaired or replacement unit
- 15 minutes to reinstall the unit in aircraft
- 15 minutes to return to the shop

While the time allotted may appear excessive, it allows for the consideration that some repair shops are not located at airport facilities.

4.5.2 Off-Aircraft Maintenance

Off-aircraft maintenance costs are those costs incurred during the actual repair of a failed module. These expenses include the cost of materials, labor, shipping, and failure documentation.

Module repair at the avionics repair shop is restricted to bench testing and removal and replacement of the failed modules within the transponder. Repair times are attributed to the transponder and to each module. Since minimal spares, e.g., one of each type, are inventoried at avionics repair shops, users may often have to wait to have their repaired units returned to them. This waiting period is reflected in the avionics repair shop and depot pipeline (turnaround) times and order/ship times for replacement modules.

No modules, with the exception of the chassis, are assumed to be repaired at the avionics shops. Rather, the failed modules are shipped to a depot, or manufacturer, for repair. Eight depots were presumed throughout this analysis because in the past there have been eight manufacturers of ATCRBS transponders.

Once the failed unit arrives at the depot it is repaired, or in some cases replaced, incurring both a materials cost and a labor cost. These costs are peculiar to the particular module being repaired. The maintenance action is then documented and the repaired item shipped back to the avionics repair shop, thus completing the *off-aircraft* maintenance cycle. Module repair was assumed to vary between 0.60 and 1.35 hours, depending on the module.

It was assumed that in the initial year of DABS implementation there would be 50 avionics repair shops. This was based on the relatively small number (207) of pulse equipment repair shops existing today as listed in the FAA Advisory Circular AC/140-7A of 18 April 1980, *Federal Aviation Administration Certificated Maintenance Agencies Directory*. We assumed that the repair shops total would increase by 15 shops per year because of the continuing increase in transponders.

CHAPTER FIVE

INDIVIDUAL AND FLEET COSTS FOR DABS IMPLEMENTATION

5.1 COST MODEL

ARINC Research Corporation adapted and updated its Economic Analysis Model (EAM) for this study to evaluate the economic impact of the DABS transponder on the low-performance general aviation aircraft community. In particular the model calculates the cost of each DABS configuration and provides a basis for comparing costs between the levels of complexity that may be designed into the general aviation transponder.

The model has been programmed in FORTRAN IV+ for use with a Digital Equipment Corporation PDP-11/34 minicomputer. It computes the expected annual and cumulative acquisition, installation, and logistic support costs for each concept. The program is flexible so that data changes can be readily implemented, sensitivity evaluations performed, or additional data outputs obtained. The program features and mathematical formulation of the EAM are documented in Appendix B to this report. Appendix C is a program listing of the EAM.

5.2 ADDITIONAL INPUTS REQUIRED BY THE MODEL

The data developed in Chapter Three consitute only a portion of the data required to compare systems or establish the cost of implementation. Many parameters contributing to the evaluation of the systems and life-cycle costs are dictated by the GA user community. These data were developed, as were other parameters required by the model, through research completed for this and other contracts by ARINC Research Corporation.

A complete list of the parameters influencing the LCC evaluation is tabulated in Appendix D to this report. All of the parameters considered influential in evaluating the relative costs and reliabilities of the systems have been programmed into the cost model.

5.3 RESULTS OF APPLYING THE ECONOMIC ANALYSIS MODEL

The ARINC Research EAM computes annual and cumulative acquisition, installation, and logistic support costs for each concept and user

combination desired. The model was programmed to print out data for one additional year beyond the assumed retrofit period of 1987 through 2000 to evaluate the effects of new aircraft production without retrofit and of maintenance and logistics costs after fleet implementation.

This section presents the results derived from the model on the basis of the parametric inputs provided for both the discrete logic and the LSI logic transponder configurations. The costs of acquisition, installation, and recurring logistics are identified separately, by aircraft. The 15-year life-cycle costs of any of the transponder configurations an aircraft owner may expect are also presented. These costs are presented in Section 5.3.1.

The fleetwide life-cycle costs of system implementation for the 18 different transponder configurations are tabulated in Section 5.3.2. Selected configurations are presented in graphic format to illustrate the year-by-year cost of system implementation.

5.3.1 Cost of Ownership Per Aircraft

The per-aircraft cost of ownership of a DABS transponder would normally consist of the initial acquisition and installation costs for equipment configurations, a proportion of the nonrecurring logistic support costs, and the cumulative life-cycle cost of aircraft maintenance during the 15 years. These costs can be combined to provide an evaluation of the systems based on both initial investment and reliability. One cost factor (amortization of manufacturer initial costs or LSI development costs) was omitted from the cost analyses presented in this chapter because of the uncertainties regarding the effect that the competitive market would have on these costs. The results we have developed without including that factor would be comparable to costs for the transponder if the Government were to develop the LSIs and supply the design to the transponder manufacturers. The possible effects of amortization are considered in Chapter Six.

The logistic suport costs are divided into two categories: nonrecurring costs associated with introduction of a new system and recurring costs experienced from normal corrective maintenance of the system. The cost categories are:

- On-aircraft maintenance
- Off-aircraft maintenance
- Spare parts
- Inventory management
- Support equipment
- Training
- Technical data and failure documentation
- Facilities

All categories contribute to the recurring logistics costs and all but on- and off-aircraft maintenance contribute to the nonrecurring logistics cost. For example, spare parts would normally be purchased by a repair facility and introduced into the inventory system. This would result in costs associated with the spares and the costs of inventory set-up, both considered nonrecurring. Upon failure of a unit, spares would be used and replacement spares ordered, generating a recurring cost of parts and documentation. The EAM computes such costs on the basis of the probability of failures.

The logistic support costs on a per-aircraft basis for the general aviation community, however, are limited to the recurring costs of maintenance, i.e., on- and off-aircraft maintenance costs incurred in repairing a failed unit. We do not expect the individual general aviation owner to stock either spare parts or test equipment and, consequently, to directly incur the management or facility costs associated with maintaining an inventory. The repair facility inventory maintenance costs are reflected in the general aviation cumulative life-cycle costs, however, since the EAM includes all logistic support cost categories.

The data in Table 5-1 identify the cost of ownership and the anticipated life-cycle costs for all DABS configurations for the low-performance general aviation aircraft community. The acquisition costs include the distribution costs expected in a competitive market.

Nonrecurring costs (e.g., spares inventory) on a per-aircraft basis are not identified, however, since they are considered inappropriate for the private general-aviation owner. The recurring logistics costs for each system are based on the historic low flight-hours-per-month average. The low cost of maintenance per aircraft is considered reasonable because average flight time per month is only 15.8 hours.

The data developed show the LSI version of DABS to have lower acquisition costs and slightly lower recurring maintenance costs than the discrete version. These costs are based on manufacturing quantities that justify the high development costs of LSIs.

5.3.2 Life-Cycle Cost

The per-aircraft cost identified in the preceding section are of the most importance to the aircraft owner, but the cumulative costs of system implementation (which include the total costs of acquisition, installation, and recurring and nonrecurring logistics) offer better insight into the total cost impact on the user community.

The cost-model outputs based on the data developed are shown in Table 5-2 in constant 1980 dollars and in Table 5-3 in discounted dollars. The constant year dollars (zero inflation rate) permit comparison of costs with any other life-cycle study of comparable length, regardless of the start of implementation, providing that the base costs are presented in 1980 dollars. The discounted dollars reflect a 10 percent discount rate, which is in accordance with OMB Circular A-94.

Table 5-1. COMPARISON OF AIRCRAFT TRANSPONDER COST DATA FOR LOW PERFORMANCE GENERAL AVIATION (PER AIRCRAFT INSTALLATION IN CONSTANT 1980 DOLLARS)

System	Acquisition	Installation		Recurring (Annual)	First Year of Ownership		Life-Cycle Cost	
		New	Retrofit	Logistic	New	Retrofit	New	Retrofit
Discrete Version								
Basic DABS	1,303	195	264	18	1,516	1,585	1,768	1,837
Diversity	1,655	242	344	30	1,927	2,029	2,347	2,449
21.5 dBW Antenna Power	1,305	195	264	18	1,518	1,587	1,770	1,837
Comm A and B	1,342	195	264	19	1,556	1,625	1,822	1,891
Comm A and B and ATARS	1,686	195	264	18	1,899	1,968	2,151	2,220
Comm A and B, ATARS, and BCAS Interface	1,745	195	264	19	1,959	2,028	2,225	2,294
Comm A, B, and C	1,476	195	264	18	1,689	1,758	1,941	2,010
Comm A, B, and C and ATARS	1,820	195	264	19	2,034	2,103	2,300	2,369
Comm A, B, C, and D	1,793	195	264	22	2,010	2,079	2,318	2,387
LSI Version								
Basic DABS	1,003	195	264	17	1,215	1,284	1,453	1,522
Diversity	1,355	242	344	28	1,625	2,017	1,727	2,119
21.5 dBW Antenna Power	1,005	195	264	17	1,217	1,286	1,455	1,524
Comm A and B	1,045	195	264	17	1,257	1,326	1,495	1,564
Comm A and B and ATARS	1,285	195	264	17	1,497	1,566	1,735	1,804
Comm A and B, ATARS, and BCAS Interface	1,285	195	264	17	1,497	1,566	1,735	1,804
Comm A, B, and C	1,142	195	264	16	1,353	1,422	1,577	1,646
Comm A, B, and C and ATARS	1,386	195	264	17	1,598	1,667	1,836	1,905
Comm A, B, C, and D	1,436	195	264	21	1,652	1,721	1,946	2,015

Table 5-2. LIFE-CYCLE COST FOR DABS TRANSPONDERS FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY (IN MILLIONS OF CONSTANT 1980 DOLLARS)				
System	Acquisition Cost	Installation Cost	Total Logistic Cost	Total Cost
Discrete Version				
Basic DABS	522.7	92.6	68.8	684.3
Diversity	664.1	118.4	108.8	891.3
21.5 dBW Antenna Power	523.7	92.6	68.9	685.2
Comm A and B	538.4	92.6	69.3	700.3
Comm A and B and ATARS	676.6	92.6	69.5	838.7
Comm A and B, ATARS, and BCAS Interface	700.1	92.6	70.2	862.9
Comm A, B, and C	592.2	92.6	66.1	750.9
Comm A, B, and C and ATARS	730.4	92.6	70.5	893.5
Comm A, B, C, and D	719.6	92.6	84.4	896.6
LSI Version				
Basic DABS	402.4	92.6	63.3	558.4
Diversity	543.7	118.4	103.0	765.1
21.5 dBW Antenna Power	403.4	92.6	63.4	559.4
Comm A and B	419.5	92.6	63.7	575.9
Comm A and B and ATARS	515.5	92.6	62.3	670.4
Comm A and B, ATARS, and BCAS Interface	515.5	92.6	62.3	670.4
Comm A, B, and C	458.2	92.6	60.1	610.9
Comm A, B, and C and ATARS	556.4	92.6	66.4	715.4
Comm A, B, C, and D	576.3	92.6	77.8	746.7

OMB Circular A-94 requires that life-cycle costs be discounted to reflect the opportunity cost of money. This means that money spent during a particular year has a greater impact on cost than does money spent one year later (assuming that all economic factors remain constant). The expected opportunity cost occurs because the money spent could have been invested to yield a rate of return. OMB specifies that because the expected rate of return is 10 percent, money should be discounted at 10 percent. Thus, one 1980 dollar will be worth approximately 51¢ in 1987 when the DABS acquisition begins, 15¢ when retrofit ends, and 13¢ when the life-cycle analysis is terminated.

In addition to preparing the data shown in Tables 5-2 and 5-3, we selected three DABS configurations to illustrate cumulative costs year by year. Figures 5-1 through 5-6 illustrate the LCC trends on a yearly basis

Table 5-3. LIFE-CYCLE COST FOR DABS TRANSPONDER FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY (IN MILLIONS OF DISCOUNTED DOLLARS)				
System	Acquisition Cost	Installation Cost	Total Logistic Cost	Total Cost
Discrete Version				
Basic DABS	152.6	27.1	16.1	195.8
Diversity	193.8	34.6	25.3	253.7
21.5 dBW Antenna Power	152.8	27.1	16.1	196.1
Comm A and B	157.1	27.1	16.2	200.4
Comm A and B and ATARS	197.4	27.1	16.3	240.9
Comm A and B, ATARS, and BCAS Interface	204.3	27.1	16.5	247.9
Comm A, B, and C	172.8	27.1	15.5	215.4
Comm A, B, and C and ATARS	213.1	27.1	16.5	256.8
Comm A, B, C, and D	210.0	27.1	19.8	256.9
LSI Version				
Basic DABS	117.4	27.1	14.8	159.3
Diversity	158.7	34.6	23.9	217.2
21.5 dBW Antenna Power	117.7	27.1	14.8	159.6
Comm A and B	122.4	27.1	14.9	164.4
Comm A and B and ATARS	150.4	27.1	14.6	192.1
Comm A and B, ATARS, and BCAS Interface	150.4	27.1	14.6	192.1
Comm A, B, and C	133.7	27.1	14.1	174.9
Comm A, B, and C and ATARS	162.4	27.1	15.5	205.0
Comm A, B, C, and D	168.2	27.1	18.2	213.5

for the discrete and LSI versions of Comm A and B, Comm A, B, and C, and Comm A, B, and C and ATARS. These three configurations were selected as being representative of possible DABS implementations. The graphs show the trends in both constant 1980 dollars and discounted dollars.

It is evident from Table 5-2 that the primary cost associated with implementing any DABS configuration is acquisition cost. The LSI versions will cost an average of 22 percent less than the DABS discrete versions. The acquisition cost for LSI logic ranges from 18 percent less for DABS with antenna diversity to 25 percent less for DABS with Comm A and B, ATARS, and BCAS interface.

(Text continues on page 5-13.)

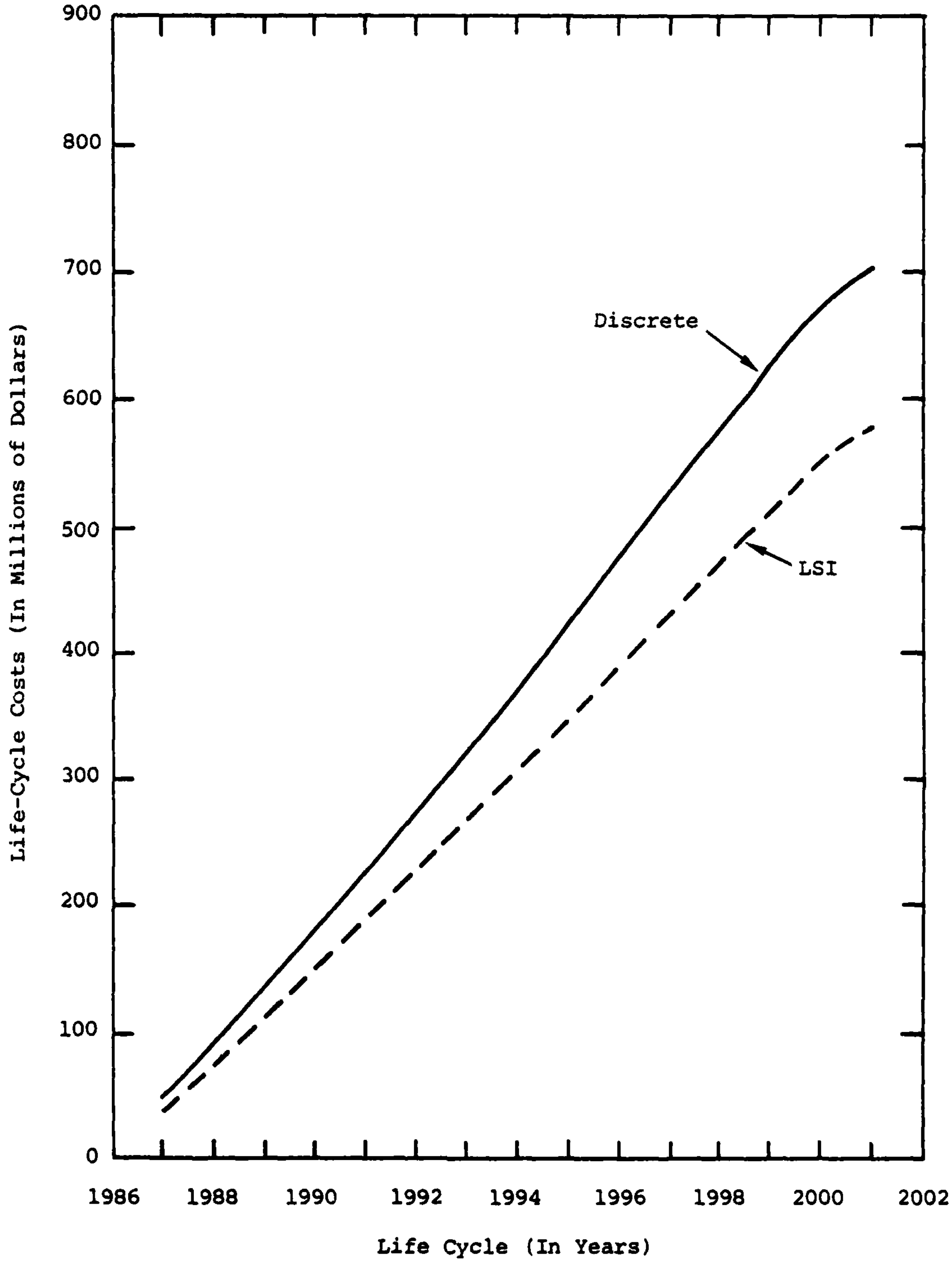

Figure 5-1. CUMULATIVE LIFE-CYCLE COST (CONSTANT 1980 DOLLARS, DABS WITH COMM A AND B)

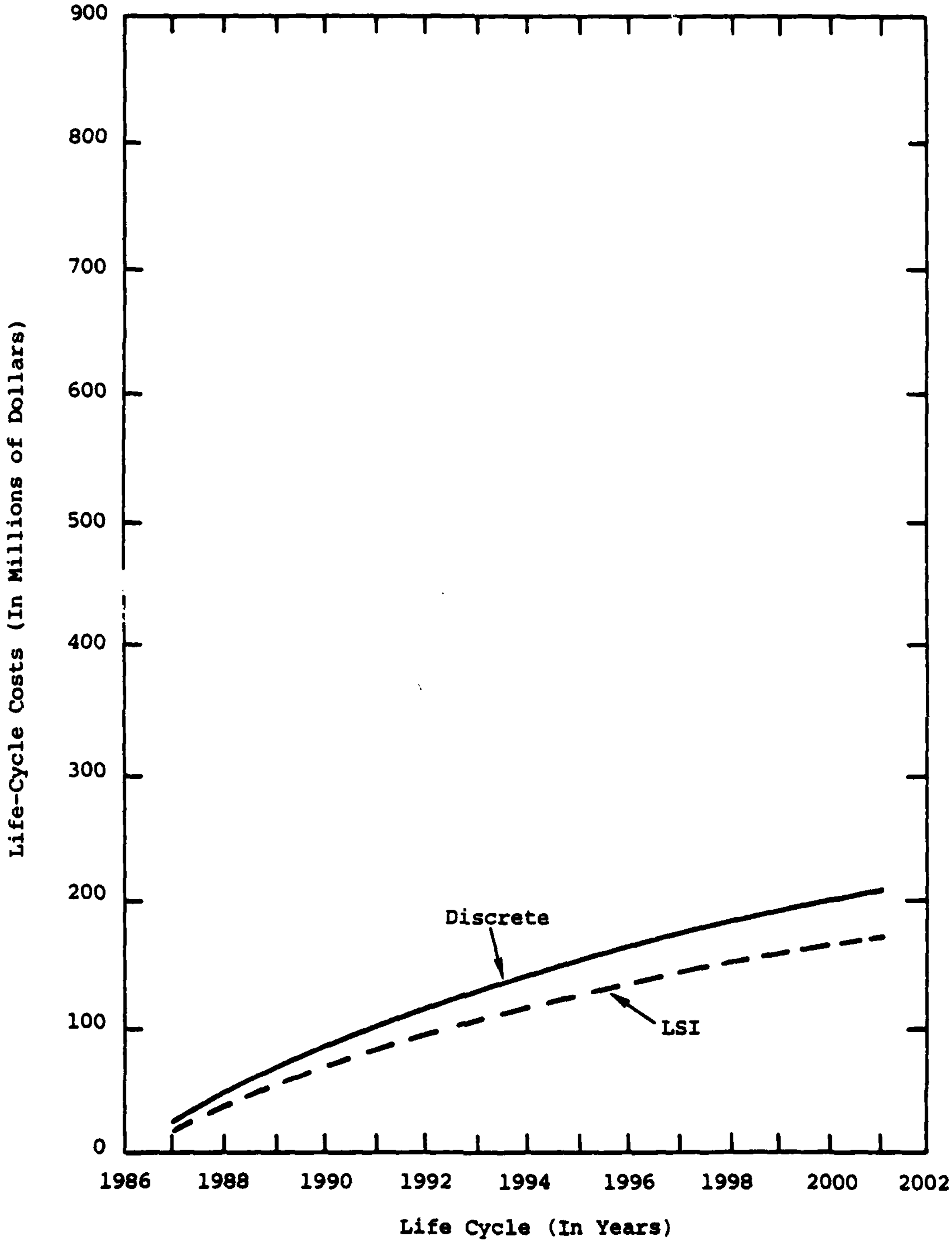

Figure 5-2. CUMULATIVE LIFE-CYCLE COST (TEN PERCENT DISCOUNT RATE, DABS WITH COMM A AND B)

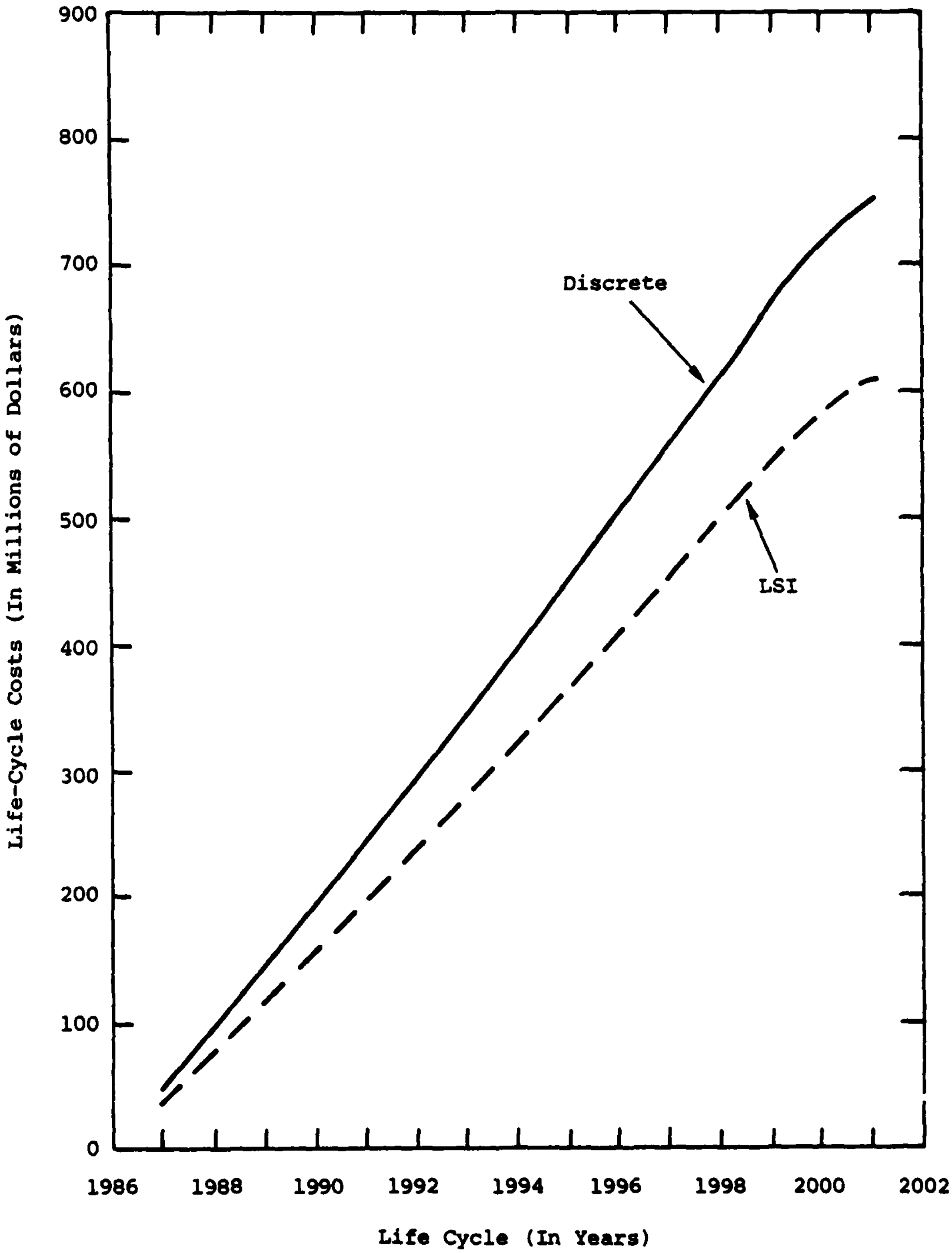

Figure 5-3. CUMULATIVE LIFE-CYCLE COST (CONSTANT 1980 DOLLARS, DABS WITH COMM A, B, AND C)

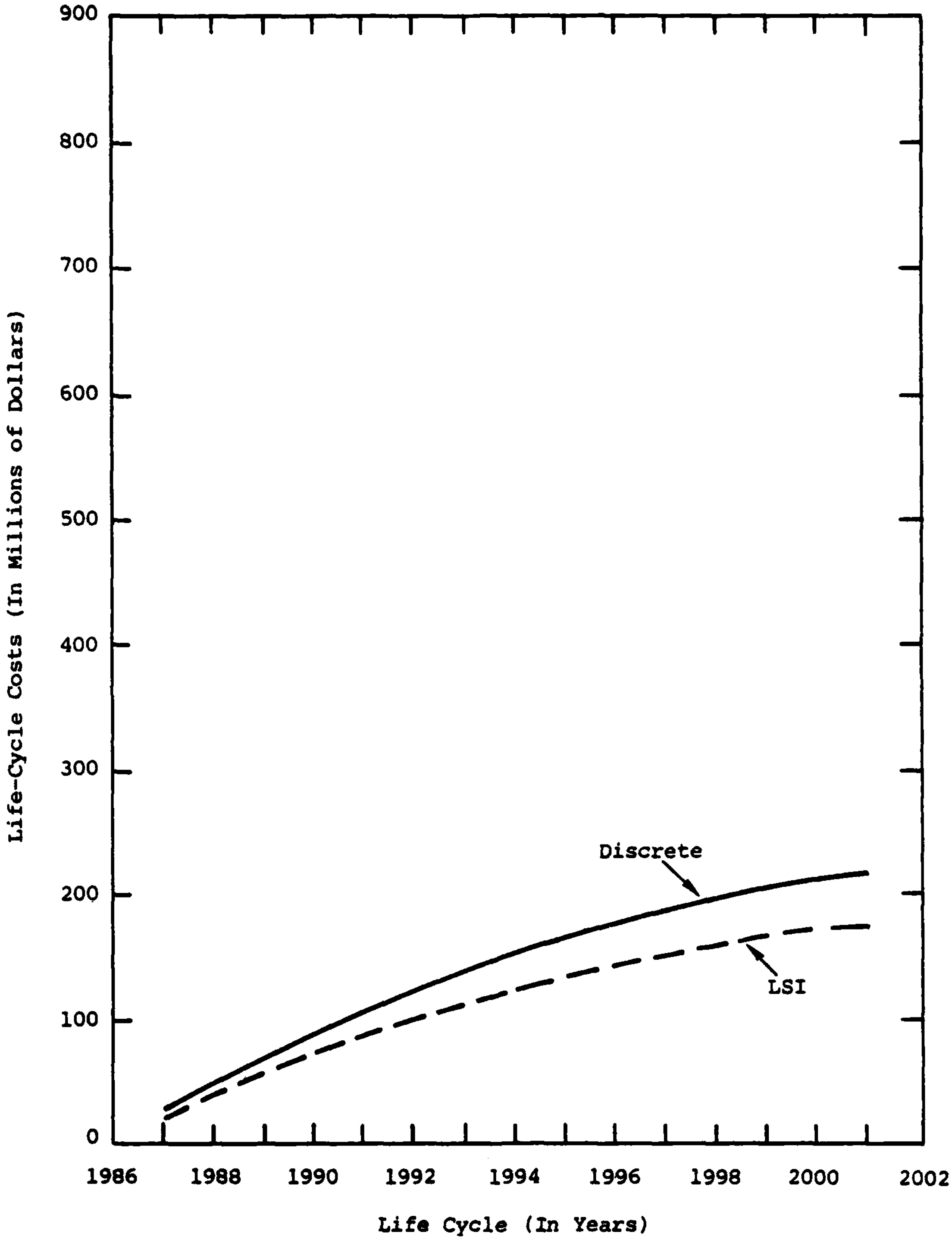

Figure 5-4. CUMULATIVE LIFE-CYCLE COST (TEN PERCENT DISCOUNT RATE, DABS WITH COMM A, B, AND C)

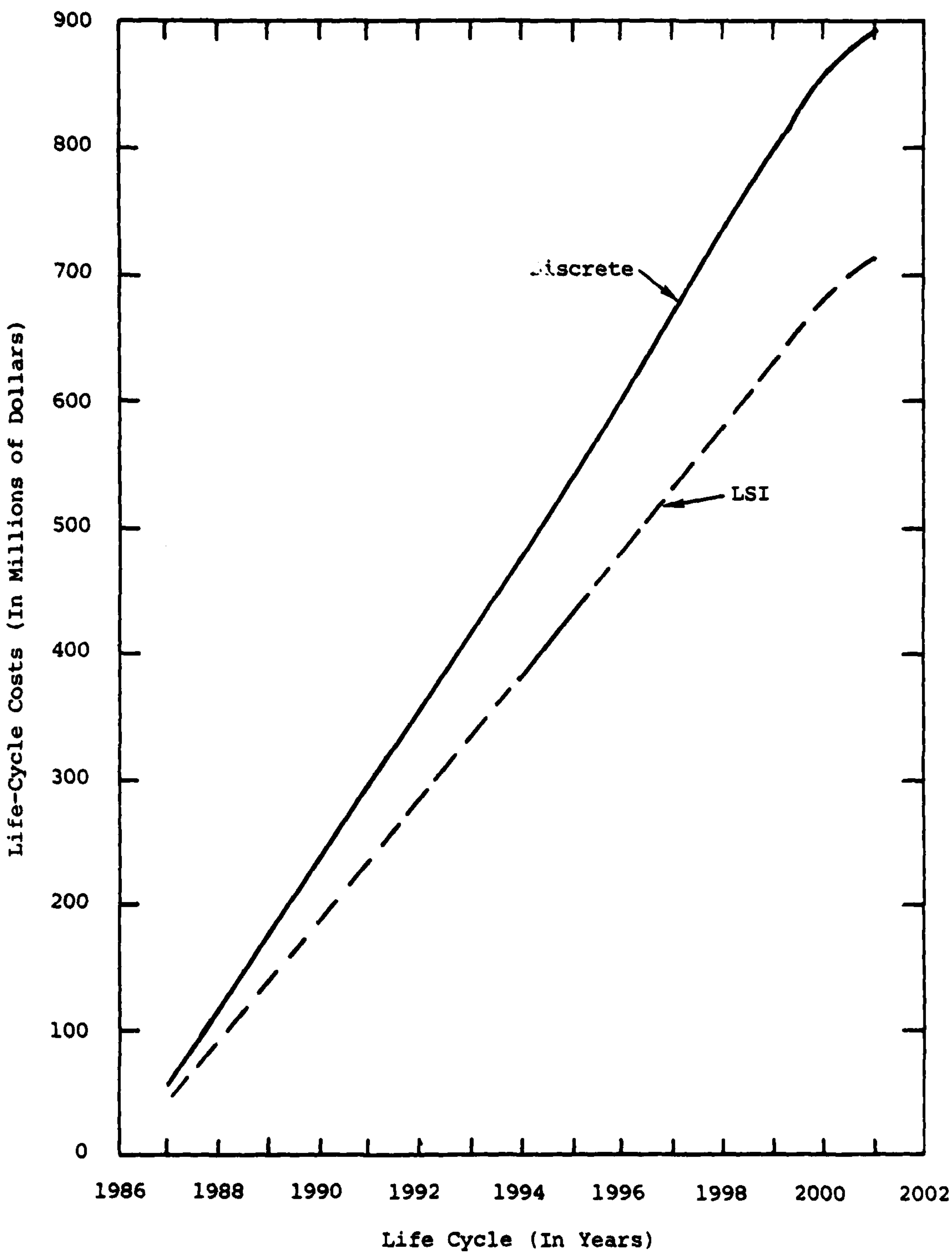

Figure 5-5. CUMULATIVE LIFE-CYCLE COST (CONSTANT 1980 DOLLARS, DABS WITH COMM A, B, AND C AND ATARS)

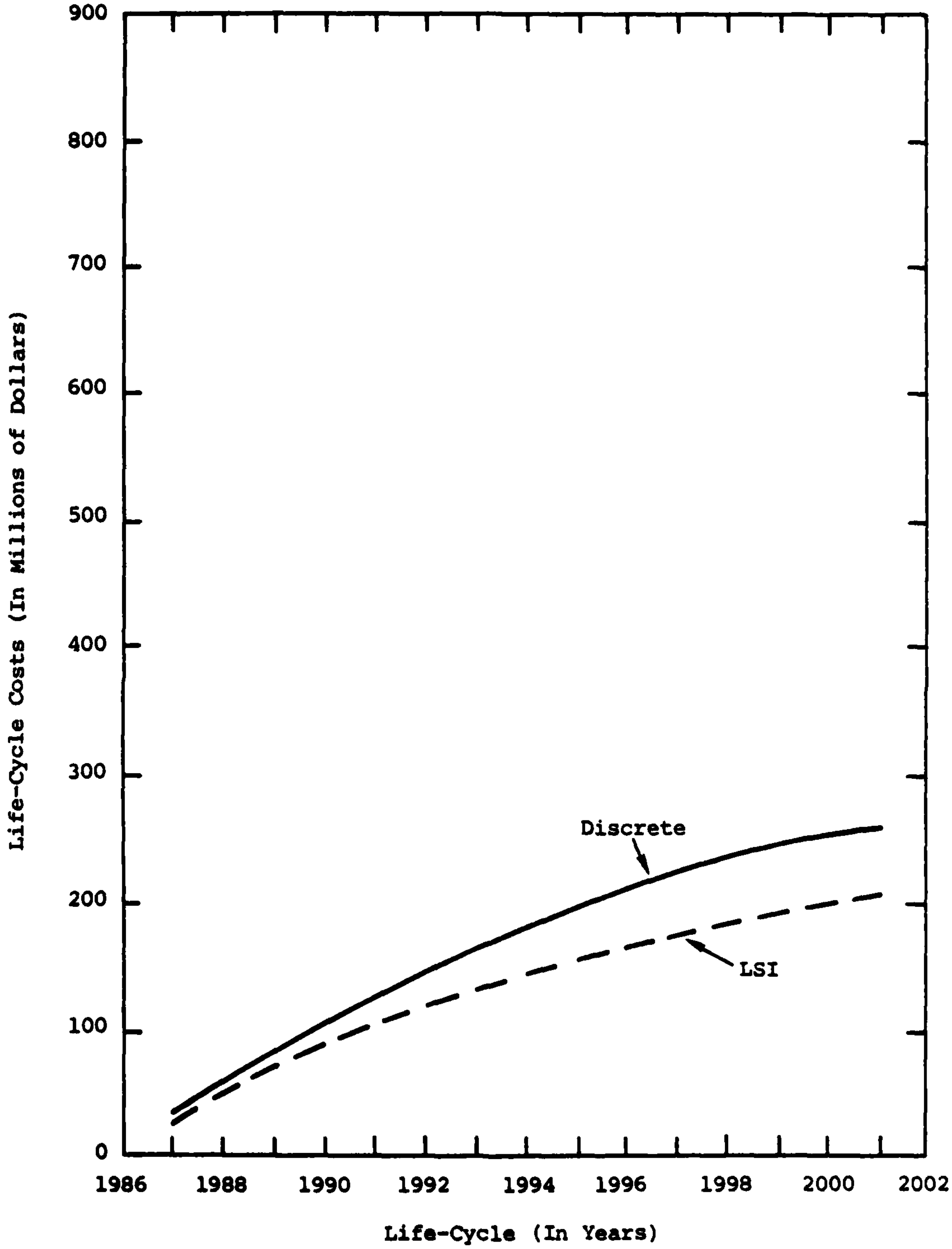

Figure 5-6. CUMULATIVE LIFE-CYCLE COST (TEN PERCENT DISCOUNT RATE, DABS WITH COMM A, B, AND C AND ATARS)

The logistic support costs are about the same for a discrete version or any LSI version except for DABS with Comm A, B, C, and D for both versions and antenna diversity for both versions.

The logistic support costs required to maintain the systems are lower for the LSI versions by approximately 8.5 percent. This overall reduction in logistic support cost required to maintain the LSI systems is due to the expected higher reliabilities associated with LSI components compared with the cumulative failures of the numerous discrete-logic components. The higher LSI reliabilities are sufficient to offset the higher material repair costs of the modules with LSIs.

The lower initial acquisition costs of the LSI configurations of the transponder, together with the lower logistic support costs, result in an average life-cycle cost 19 percent less than the cost of the discrete-logic versions. The life-cycle costs range from 14 percent less for antenna diversity to 29 percent less for Comm A and B, ATARS, and BCAS interface. The cost of the LSI version of Comm A and B, ATARS, and BCAS interface is substantially lower because all of the BCAS components are incorporated into the same LSI that includes the Comm A and B components.

Figures 5-1, 5-3, 5-5 (in constant 1980 dollars), 5-2, 5-4, and 5-6 (in discounted dollars) all show that the life-cycle costs behave similarly without regard for discrete or LSI versions or DABS capability. The differences in cumulative costs for LSI and discrete versions are a result of the differences in acquisition costs.

CHAPTER SIX

SENSITIVITY OF THE DABS COST ANALYSES TO PARAMETER VARIATIONS AND ALTERNATIVE ASSUMPTIONS

In the development of data for the cost analyses of the DABS system concepts in Chapters Three and Four, assumptions had to be made regarding operational scenarios and system parameters. Because of this we reviewed the cost analyses for their sensitivity to parameter variations and alternative scenarios.

The cases considered in this review were as follows:

- The sensitivity of life-cycle costs to variations in system MTBFs
- The sensitivity to changes in LSI material costs
- The effect of including LSI amortization costs in the analyses

The reasons for conducting these additional analyses and the results of the analyses are presented in the following sections.

6.1 SENSITIVITY OF LIFE-CYCLE COST TO MTBF VARIATIONS

Since the mean time between failures (MTBF) is usually difficult to predict accurately and since MTBF has a major impact on the life-cycle cost, the effect of MTBF variations on DABS life-cycle costs was evaluated. Figures 6-1 and 6-2 illustrate the effect of variations in the developed system MTBFs on the life-cycle costs predicted for the DABS configuration with Comm A and B and DABS with Comm A, B, and C and ATARS. Since the other configurations illustrated similar characteristics, they are not presented here. The figures show the system MTBFs developed in Chapter Three. A comparison of the discrete and LSI versions of the DABS transponder is also presented. Constant 1980 dollars were chosen to permit comparison with other life-cycle costs, regardless of implementation dates, on the basis of 1980 dollar costs.

Figures 6-1 and 6-2 both indicate that the life-cycle-cost estimates can be substantially affected by variations in system MTBFs. In both the discrete and LSI versions of either DABS configuration, the life-cycle costs are in the knee of the cost-versus-MTBF curve. An MTBF of 500 hours less than predicted would result in a 4 to 5 percent increase in costs for both the discrete and LSI versions of DABS with Comm A and B. An MTBF of

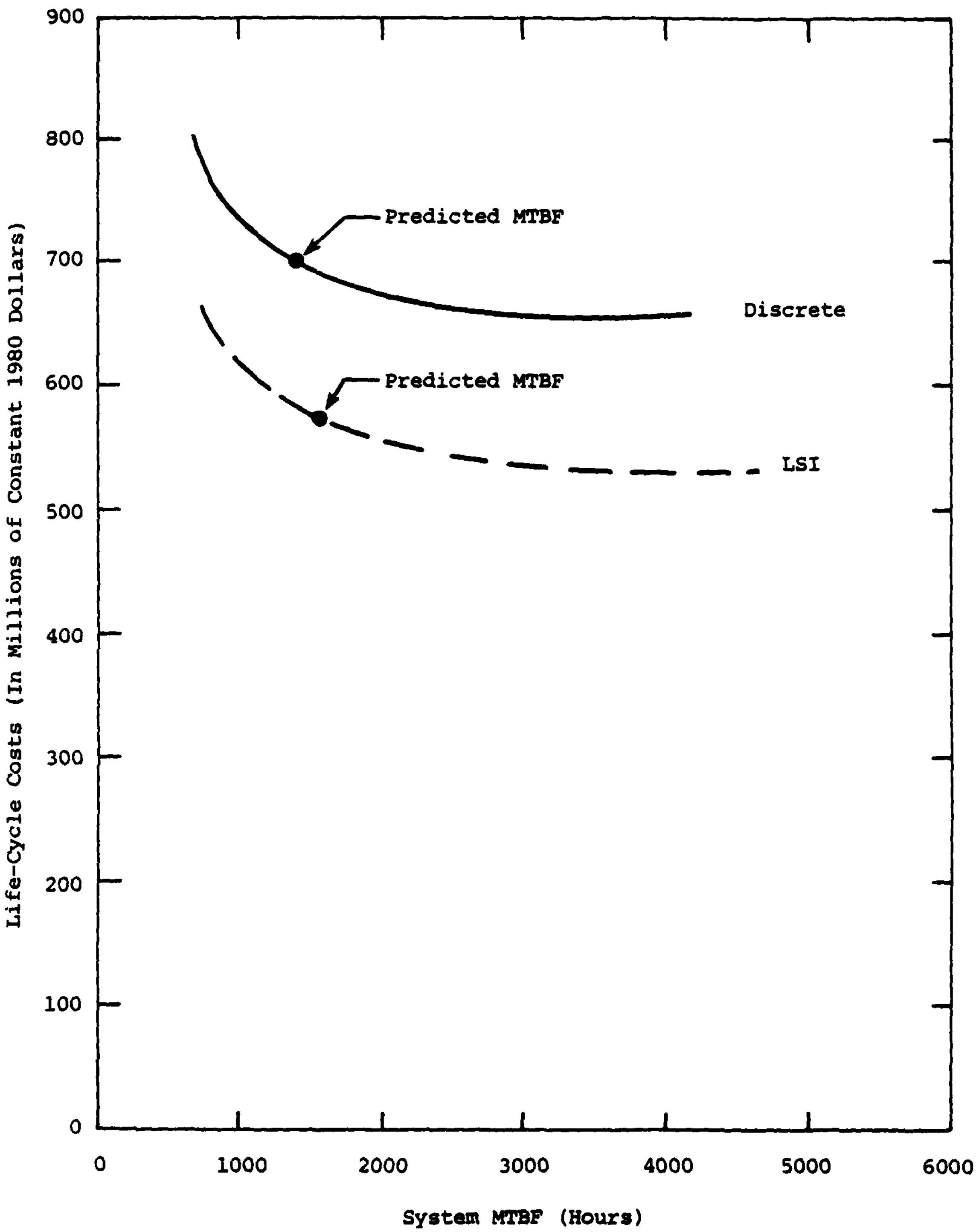

Figure 6-1. LIFE-CYCLE COSTS AS A FUNCTION OF TRANSPONDER MTBF (DABS WITH COMM A AND B)

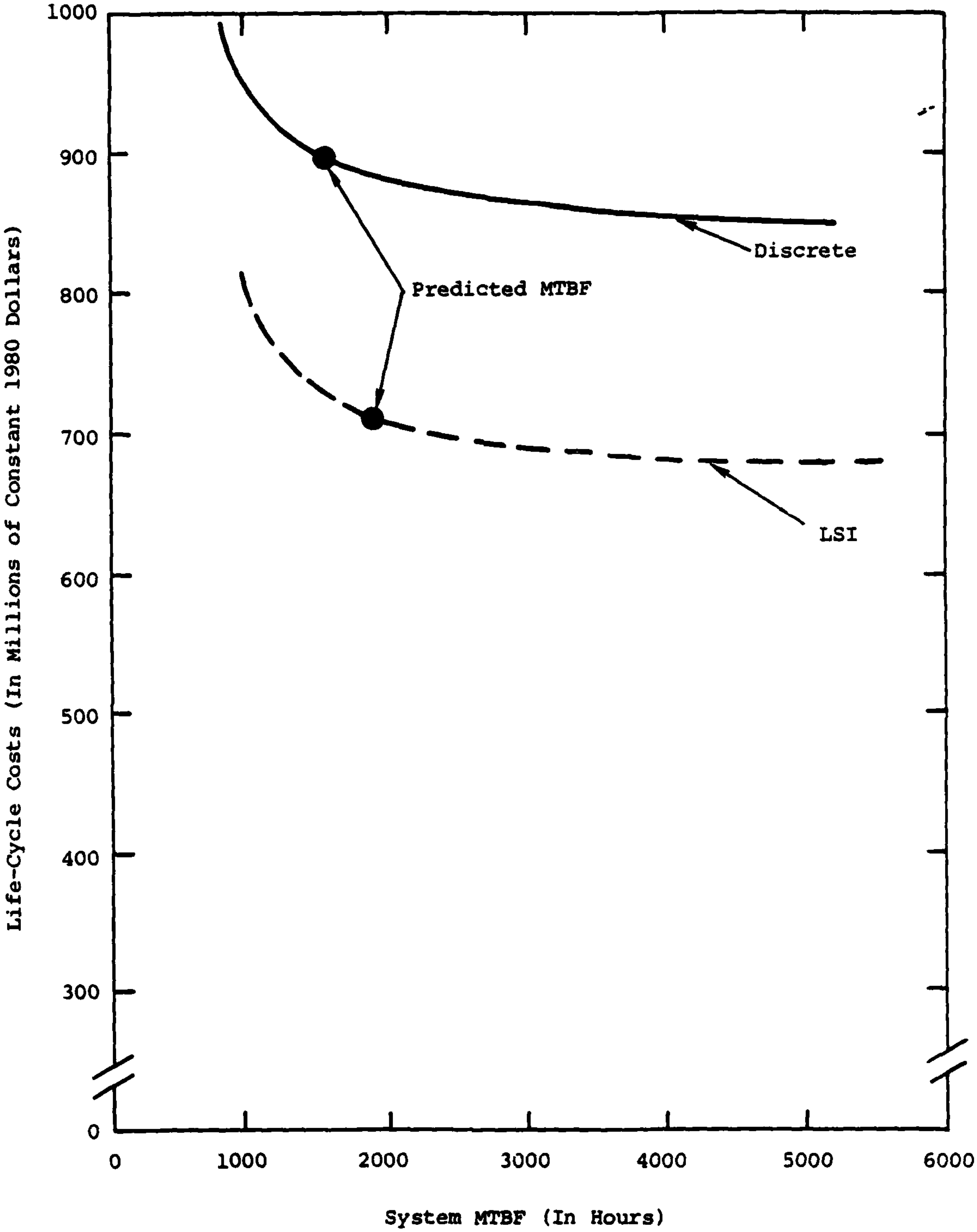

Figure 6-2. LIFE-CYCLE COSTS AS A FUNCTION OF TRANSPONDER MTBF (DABS WITH COMM A, B, AND C, AND ATARS)

500 hours more than predicted would result in a decrease in costs of approximately 2 percent. For DABS with Comm A, B, and C and ATARS, an MTBF of 500 hours less than predicted for both the discrete and LSI versions would result in a 3 percent increase in costs; an MTBF of 500 hours greater than predicted would result in a 2 percent decrease in cost for either version.

Figures 6-1 and 6-2 also provide a basis for comparing the discrete and LSI versions of a given transponder configuration to identify any MTBF variations that would make the discrete systems less costly than the LSI systems. Since the major factor in the life-cycle cost is acquisition cost, Figures 6-1 and 6-2 make clear that LSI MTBFs would require major variations to make the discrete systems more attractive than the LSI systems.

6.2 SENSITIVITY OF LIFE-CYCLE COST TO LSI AND MATERIAL COST

It is apparent from the various tables comparing discrete component and LSI transponder configurations that acquisition costs are the predominant factor in life-cycle costs. To evaluate the effect of LSI-component costs on the life-cycle cost we varied the cost of LSIs used in DABS with Comm A, B, and C and ATARS configuration from the predicted value of $10 per LSI to $20 per LSI and then to $50 per LSI. This variance affected both acquisition and support costs because of the increased material cost for repair. Table 6-1 and Figure 6-3 compare the results.

Table 6-1. INCREASE IN LIFE-CYCLE COST RESULTING FROM AN INCREASE IN LSI COST (IN CONSTANT 1980 DOLLARS) (DABS WITH COMM A, B, AND C AND ATARS)

LSI Cost	Acquisition Cost	Installation Cost	Total Logistics Cost	Total Program Cost
10	556.4	92.6	66.4	715.4
20	608.5	92.6	66.8	768.0
50	751.3	92.6	68.1	912.0
Discrete Cost	730.4	92.6	70.5	893.5

Table 6-1 illustrates the increases in life-cycle-cost components as well as in the total life-cycle cost as the LSI costs are increased. The discrete component costs are also shown for comparative purposes. Even though the acquisition costs and the life-cycle costs using $50 LSIs (the Table 6-1 configuration uses five LSIs) exceed those of the discrete component configuration, the total logistic costs for the LSI configuration are

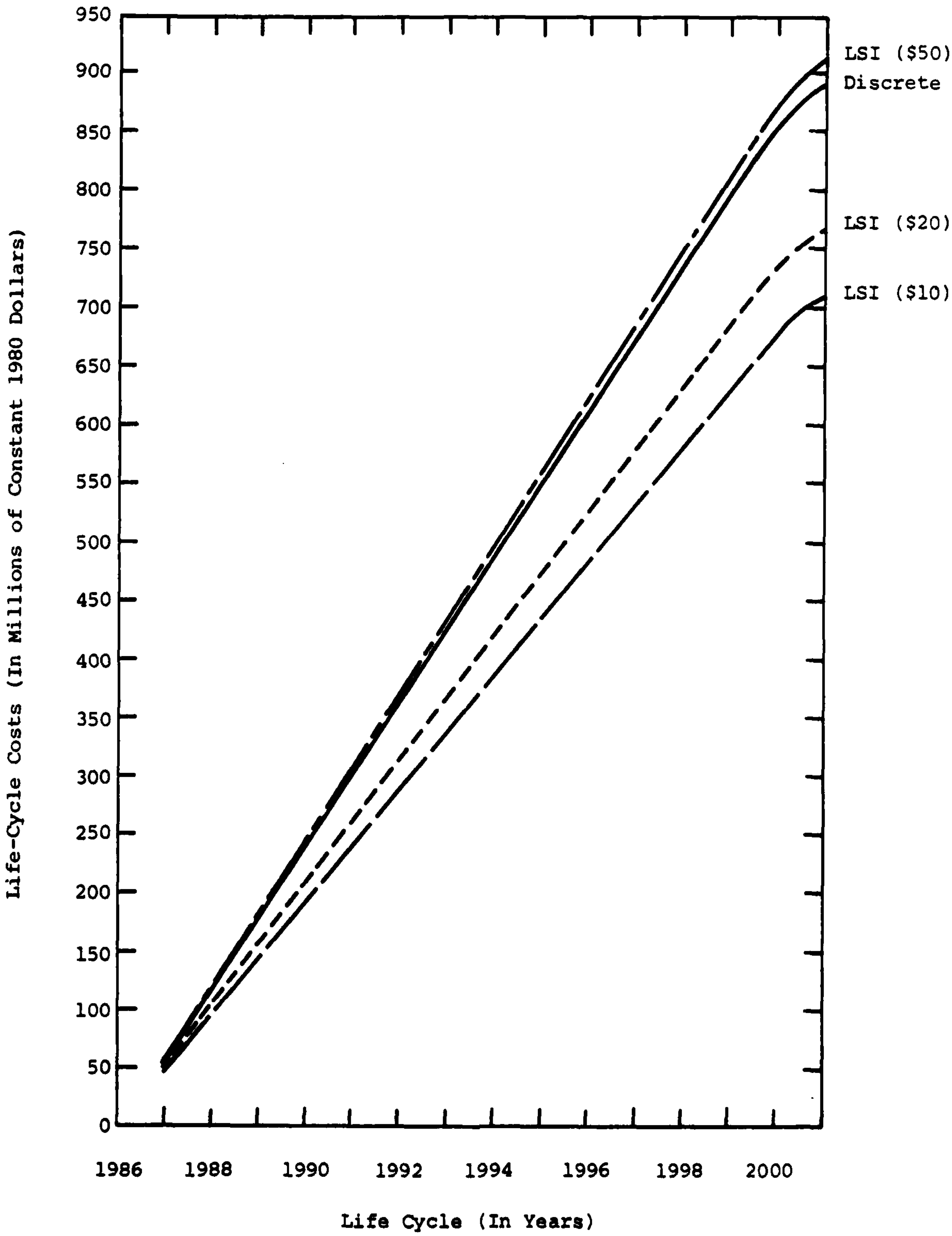

Figure 6-3. CUMULATIVE LIFE-CYCLE COST (DABS WITH COMM A, B, AND C AND ATARS)

still less than those of the discrete configuration. A linear plot of the LSI acquisition costs indicates that an LSI costing approximately $46 would have the same acquisition costs as the discrete component version.

Figure 6-3 illustrates the cumulative life-cycle costs for the different LSI versions.

6.3 THE EFFECT OF INCLUDING AMORTIZATION OF MANUFACTURERS' LSI DEVELOPMENT COSTS

The costs associated with production start-up, tooling, engineering, and development of LSI logic are normally included in a manufacturer's selling price. However, in the review of possible ways to evaluate these amortization costs, it was recognized that a competitive market with multiple manufacturers would probably modify and reduce the normally expected amortization costs. Therefore, amortization costs were eliminated from the cost analysis in Chapter Five. Nevertheless, it was desirable to re-evaluate the life-cycle costs with the effect of LSI development amortization included in order to determine if any of the cost evaluations would be altered.

The cost of LSI development was based on ARINC Research experience in other studies and information provided through informal discussion with King Radio and Bendix Aviation, both corporations with LSI development capability and experience. The costs to be amortized were taken as $100,000 per LSI per manufacturer, with each manufacturer developing its own LSIs and amortizing the cost of development over the first two years of production.

The amortization costs that were dependent on configuration were converted into per-transponder costs on the basis of production quantities of 3,500 units per year. The resultant increased cost per unit was applied to all systems manufactured and installed during the first two years of system implementation under the assumptions that there would be several manufacturers and all manufacturers engaged in the production of the systems would have similar LSI development costs. The expected cost increase of a DABS configuration where amortization is included is shown in Table 6-2. The costs for LSI development to be amortized by the several manufacturers during the first two years of production are $400,000 per manufacturer for a four-LSI configuration and $500,000 per manufacturer for a five-LSI configuration.

Figures 6-4 and 6-5 present the life-cycle cost of a four-LSI configuration and a five-LSI configuration with amortization costs included. Figure 6-4 presents the four-LSI DABS with Comm A and B configuration and compares the life-cycle cost with and without LSI development cost amortization. Even though the actual life-cycle cost is approximately $5.1 million higher with amortization included this is only a 0.89 percent increase in life-cycle cost. Figure 6-5, which illustrates the five-LSI DABS with Comm A, B, and C and ATARS configuration, is comparable to Figure 6-4. Figure 6-5 shows an increase of approximately $6.3 million for the life-cycle cost but again this is an increase of only 0.88 percent in overall cost. These same

Table 6-2. INCREASE IN DABS CONFIGURATION COST DUE TO AMORTIZATION OF LSI DEVELOPMENT (FIRST TWO YEARS OF PRODUCTION)		
	Four-LSI Version	Five-LSI Version
Cost Increase per Transponder	$114.28 (List) 57.14 (OEM)	$142.86 (List) 71.43 (OEM)

LSI development costs applied to a lower life-cycle cost such as the five-LSI DABS with Comm A and B and ATARS configuration would result in an increase of 0.94 percent in the life-cycle cost. Both figures illustrate that although the cost increases in each configuration are appreciable, they are not evident when compared with the total expected expenditures. Amortization has little effect on the relative costs of the transponders because the equipment acquisition costs dominate the life-cycle costs.

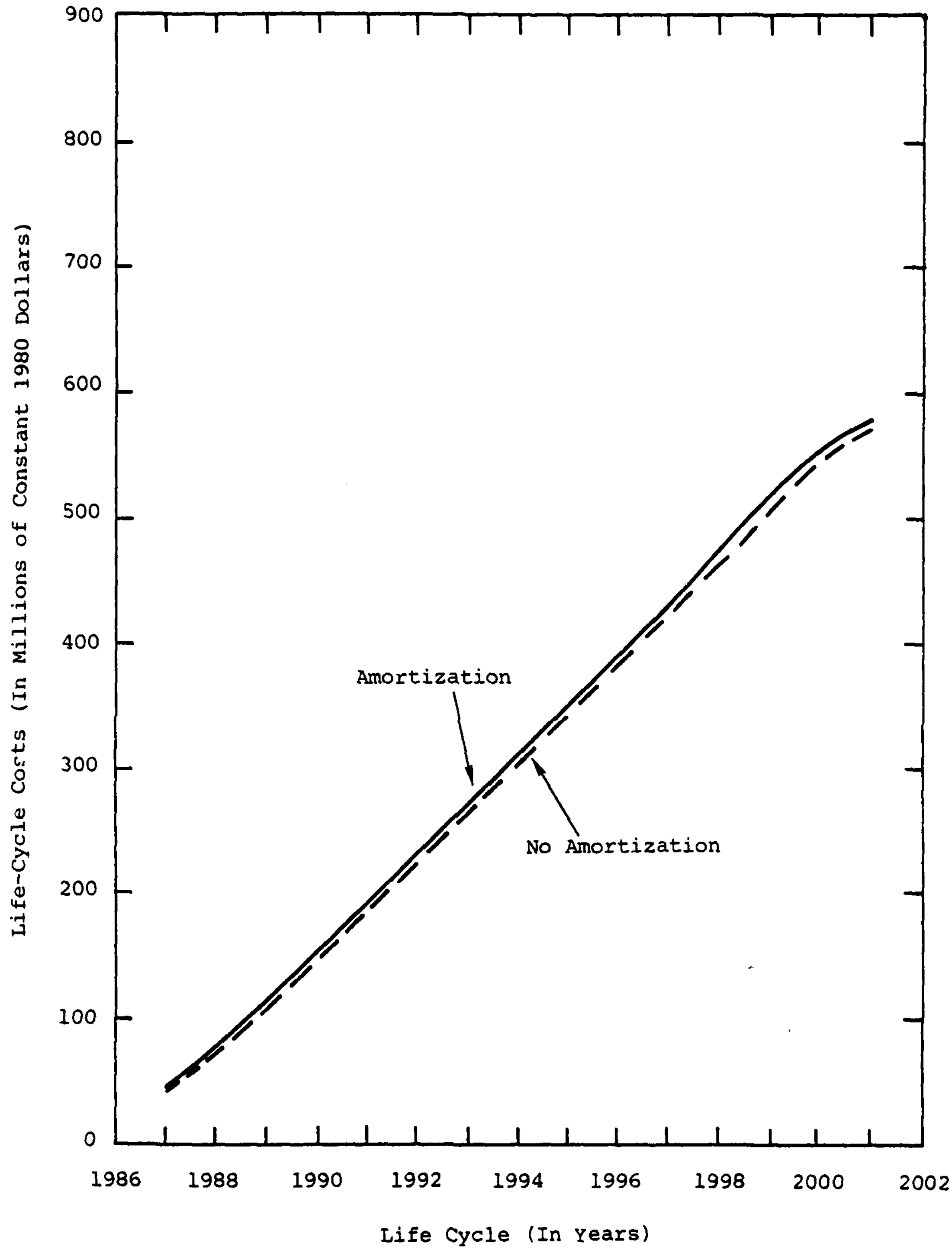

Figure 6-4. CUMULATIVE LIFE-CYCLE COST WITH AND WITHOUT LSI DEVELOPMENT AMORTIZATION (DABS WITH COMM A AND B)

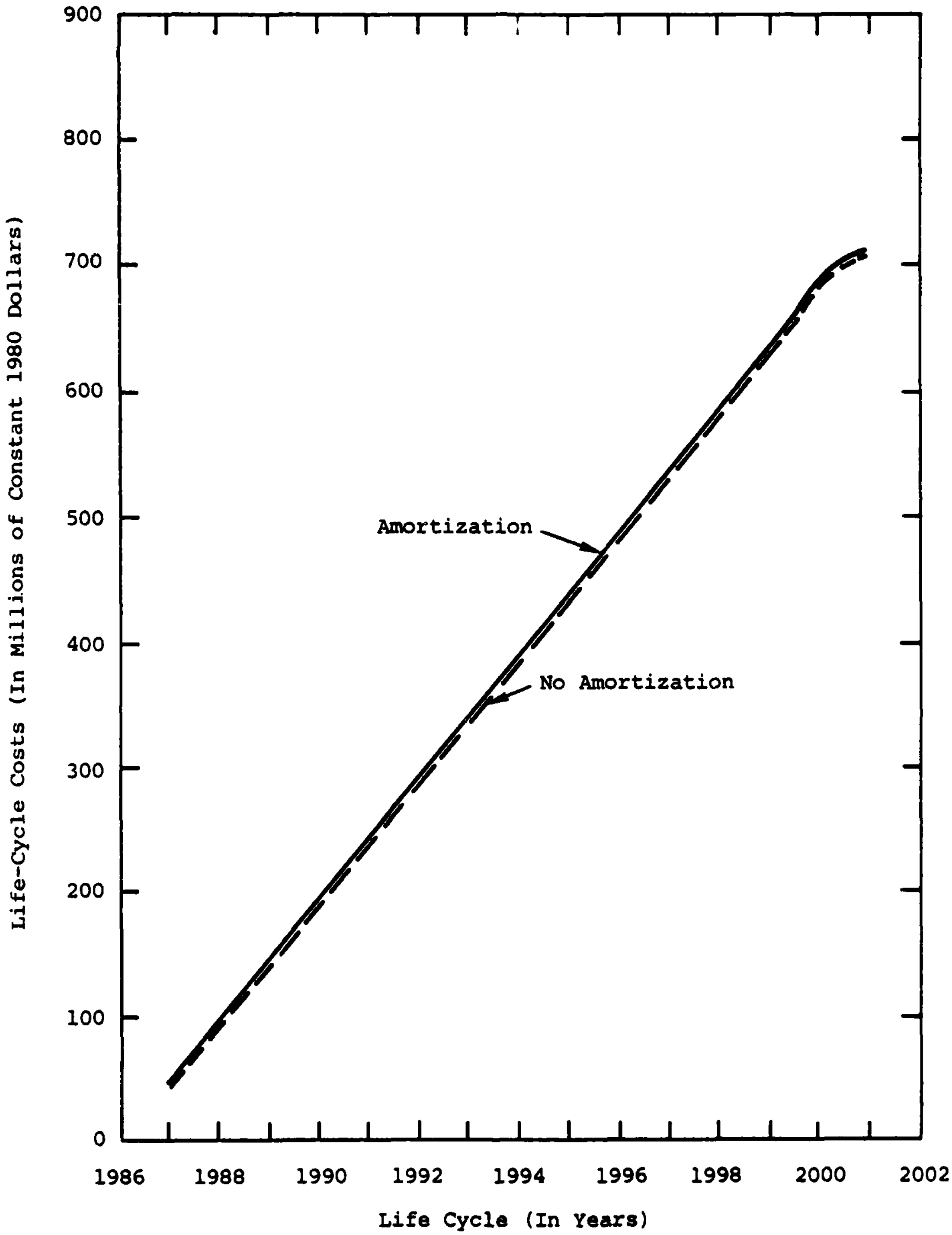

Figure 6-5. CUMULATIVE LIFE-CYCLE COST WITH AND WITHOUT LSI DEVELOPMENT AMORTIZATION (DABS WITH COMM A, B, AND C AND ATARS)

CHAPTER SEVEN

RESULTS OF EVALUATIONS

This study has developed costs of various DABS transponder configurations using both discrete and LSI components to assess the cost impact of varying levels of sophistication in a DABS transponder designed for the low-performance general aviation aircraft community (limited to single-engine and light twin-engine aircraft). Costs were also generated for an existing ATCRBS transponder (whose advertized prices are available for comparison with the study results) to lend credibility to pricing techniques used for this analysis. Calculations of DABS transponder costs were based on the accounting method of cost estimating. The transponder design data used for the cost analysis came from DABS circuit designs developed by ARINC Research Corporation. The production cost data were developed through detailed analysis of the methods of several leading avionics manufacturers producing either high- or low-performance aircraft equipment. Total system costs were evaluated with the aid of an economic analysis model. This chapter summarizes the results of the cost analyses.

7.1 COST DATA OF TRANSPONDER CONFIGURATIONS EVALUATED

The transponder costs developed during this study are summarized in Table 7-1. The values indicate the probable selling price of the transponders to the low-performance general-aviation aircraft user. Appropriate markups for distribution have been included on the basis of known or expected practices of the avionics manufacturers. All costs are based on the 1980 dollar without inflation. Potential variability in costs exists as a function of the production volume dictated by user demand. However, comparison of transponder costs based on the data presented is possible since a uniform production quantity was assumed in the evaluation of each concept.

The costs developed in this study considered various configurations of DABS transponders with both discrete and LSI logic designs. Since each configuration is unique, requiring designs that optimize the data processing for that configuration, the difference between any sets of costs in Table 7-1 should not be considered as the expected cost of later adding the particular capability. For example the cost of adding ATARS capability to an existing DABS transponder with Comm A and B capability should not be expected to be only $430, the difference between the costs of installing DABS with and without ATARS. Rather, the cost of the DABS with ATARS can

be expected to be $2,093 if designed originally into the system, and the cost of DABS without ATARS would be only $1,663. The cost advantage for each design when LSI technology is introduced must be considered only after the development cost of LSIs is amortized during the early part of transponder introduction. Table 7-1 allows a comparative analysis of the costs associated with designing given capabilities into a transponder.

Table 7-1. ACQUISITION COST OF TRANSPONDERS (IN CONSTANT 1980 DOLLARS)

Transponder Configuration	Components	
	Discrete	LSI
ATCRBS	718	--
Basic Surveillance DABS	1,614	1,239
Basic DABS with Antenna Diversity	2,054	1,679
Basic DABS with 21.5 dBW Antenna	1,617	1,242
DABS with Comm A and B	1,663	1,293
DABS with Comm A and B and ATARS	2,093	1,592
DABS with Comm A and B, ATARS, and BCAS Interface	2,167	1,592
DABS with Comm A, B, and C	1,830	1,413
DABS with Comm A, B, and C and ATARS	2,261	1,719
DABS with Comm A, F, C, and D	2,227	1,781

7.2 LIFE-CYCLE COST FOR THE USER COMMUNITY

The life-cycle costs for each transponder configuration are summarized in Tables 7-2 and 7-3. The results are presented both by aircraft and for the entire low-performance general aviation aircraft community. The unit acquisition cost shown in Table 7-2 is different from the unit acquisition cost shown in Table 7-1 because the life-cycle-cost model allows for the normal distributor discount offered when the distributor installs the avionics in the aircraft. The individual-aircraft-owner costs are likely to be of the most interest to the general aviation community, while the total user community life-cycle cost allows an evaluation of the overall cost impact of implementing any particular DABS configuration. Costs are presented for both constant 1980 dollars and discounted 1980 dollars. It is apparent from Table 7-3 that the LSI versions of DABS transponders would have a lower life-cycle cost than the discrete versions. This can be traced to their acquisition costs.

Table 7-2. COMPARISON OF AIRCRAFT TRANSPONDER COST DATA FOR LOW PERFORMANCE GENERAL AVIATION (PER AIRCRAFT INSTALLATION IN CONSTANT 1980 DOLLARS)

System	Acquisition	Installation		Recurring (Annual)	First Year of Ownership		Life-Cycle Cost	
		New	Retrofit	Logistic	New	Retrofit	New	Retrofit
Discrete Version								
Basic DABS	1,303	195	264	18	1,516	1,585	1,768	1,837
Diversity	1,655	242	344	30	1,927	2,029	2,347	2,449
21.5 dBW Antenna Power	1,305	195	264	18	1,518	1,587	1,770	1,837
Comm A and B	1,342	195	264	19	1,556	1,625	1,822	1,891
Comm A and B and ATARS	1,686	195	264	18	1,899	1,968	2,151	2,220
Comm A and B, ATARS, and BCAS Interface	1,745	195	264	19	1,959	2,028	2,225	2,294
Comm A, B, and C	1,476	195	264	18	1,689	1,758	1,941	2,010
Comm A, B, and C and ATARS	1,820	195	264	19	2,034	2,103	2,300	2,369
Comm A, B, C, and D	1,793	195	264	22	2,010	2,079	2,318	2,387
LSI Version								
Basic DABS	1,003	195	264	17	1,215	1,284	1,453	1,522
Diversity	1,355	242	344	28	1,625	2,017	1,727	2,119
21.5 dBW Antenna Power	1,005	195	264	17	1,217	1,286	1,455	1,524
Comm A and B	1,045	195	264	17	1,257	1,326	1,495	1,564
Comm A and B and ATARS	1,285	195	264	17	1,497	1,566	1,735	1,804
Comm A and B, ATARS, and BCAS Interface	1,285	195	264	17	1,497	1,566	1,735	1,804
Comm A, B, and C	1,142	195	264	16	1,353	1,422	1,577	1,646
Comm A, B, and C and ATARS	1,386	195	264	17	1,598	1,667	1,836	1,905
Comm A, B, C, and D	1,436	195	264	21	1,652	1,721	1,946	2,015

Table 7-3. SUMMARY OF LIFE-CYCLE COSTS FOR DABS TRANSPONDERS FOR THE LOW-PERFORMANCE GENERAL AVIATION AIRCRAFT COMMUNITY

Transponder Configuration	Constant 1980 Dollars (In Millions)	Discounted 1980 Dollars (In Millions)
Discrete Version		
Basic Surveillance DABS	684.3	195.8
Basic DABS with Antenna Diversity	891.3	253.7
Basic DABS with 21.5 dBW at Antenna	685.2	196.1
DABS with Comm A and B	700.3	200.4
DABS with Comm A and B and ATARS	838.7	240.9
DABS with Comm A and B, ATARS, and BCAS Interface	862.9	247.9
DABS with Comm A, B, and C	750.9	215.4
DABS with Comm A, B, and C and ATARS	893.5	256.8
DABS with Comm A, B, C, and D	896.6	256.9
LSI Version		
Basic Surveillance DABS	558.4	159.3
Basic DABS with Antenna Diversity	765.1	217.2
Basic DABS with 21.5 dBW at Antenna	567.1	159.6
DABS with Comm A and B	575.9	164.4
DABS with Comm A and B and ATARS	670.4	192.1
DABS with Comm A and B, ATARS, and BCAS Interface	670.4	192.1
DABS with Comm A, B, and C	610.9	174.9
DABS with Comm A, B, and C and ATARS	715.4	205.0
DABS with Comm A, B, C, and D	746.7	213.5

7.3 DISCUSSION OF SENSITIVITY ANALYSIS

Major variations in the reliability data were considered to determine if there were any conditions that would cause a significant change in the relative life-cycle costs between discrete and LSI component transponder configurations. It was shown that the relative life-cycle costs are virtually unaffected by MTBF variations within the two configurations. It was shown that a 500-hour reduction in MTBF from that predicted would result in an approximate 4 percent life-cycle cost increase and a 500-hour increase would reduce life-cycle costs by 2 percent.

LSI component costs were evaluated to assess the effect an increase in assumed LSI cost would have on the life-cycle costs. It was determined that for the scenarios used the LSI component cost would have to increase by more than 350 percent (from $10 to $46) before the LSI life-cycle acquisition costs would equal the discrete component acquisition costs. Even then the required LSI logistic support costs would be less than those for the discrete component configuration.

Amortization of LSI development costs was analyzed to determine the effect of the Government sponsoring LSI development (no amortization costs) as opposed to the avionics manufacturing community developing LSIs in the competitive market. It was determined that the effect of the manufacturers developing LSIs on their own was negligible over the life cycle. Private development of LSI added approximately 0.89 percent to the total life-cycle costs with full amortization taking place over the first two years of production. For the individual owner buying transponders during the first two years of implementation this translates into an approximate $114 increase in transponder list price for a configuration requiring four LSIs and a $142 increase in list price for a transponder configuration requiring five LSIs.

7.4 RELATION OF THE DABS COST ANALYSIS TO THE IMPLEMENTATION OF A NATIONAL DABS SYSTEM

This study has been concerned with the cost evaluation of the airborne portion of the DABS concept; it has not addressed other key issues that will most likely affect the development and implementation of a national DABS system. For example, the operability of the system has not been evaluated and there has been no human-engineering evaluation of an integrated display. A change in the presentation of data on the display or going to a separate display unit could have a major effect on the costs presented in this study.

In addition, the analyses and conclusions reported herein have been based on the assumption that all aircraft will install DABS equipment. However, if there is a significant change from this policy, so that only a portion of the total aviation community chooses to be DABS-equipped, or the time of implementation is extended well beyond the 14-year retrofit period assumed, then the costs of the DABS components will increase, because they are controlled by the production quantities required to meet the new demand for equipment.

While there are many factors such as the above that must be considered by the FAA, we believe the cost analysis of all levels of DABS sophistication will be key elements in the ultimate selection of a minimum operational DABS configuration.

APPENDIX A

SYSTEM PARTS LIST AND COST-DEVELOPMENT DATA SHEETS

This appendix contains the work-sheets used to develop costs of modules and systems employed in the various DABS configurations. These costs were the basis for the calculations presented in Chapter Three of this report. The sheets are grouped by system configuration in the 19 sections of this appendix.

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APPENDIX A-1

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM TRANSPONDER

(ATCRBS)

SYSTEM GENERAL AVIATION TRANSPONDER

SHEET 1 OF 5

SUB-ASSEMBLY RECEIVER

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL.RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
P.C. BOARD	1	4.00	4.00	818	25	-	-	-
CD 6585	1	.48	.48		5	.155	.155	.074
FF 1100	1	.53	.53		5	.155	.155	.082
IN 916	1	.05	.05		5	.361	.361	.018
2N 5133	3	.13	.39		18	1.266	3.798	.494
2N 5138	3	.12	.36		18	1.266	3.798	.456
CAPACITOR	3	.19	.57		15	.160	.480	.091
CAPACITOR-DISC	29	.13	3.77		145	.629	18.241	2.371
RESISTOR	37	.03	1.11		185	.013	.481	.014
RESISTOR-VAR.	3	.35	1.05		45	3.242	9.726	3.404
TRANSISTOR	6	.24	1.44		36	.596	3.576	.858
INDUCTOR	1	.35	.35		5	.475	.475	.166
COIL	4	.12	.48		24	.069	.276	.033
CHOKE	2	.18	.36		20	2.120	4.240	.763
TRANSFORMER,RF	1	1.35	1.35		40	8.938	8.938	12.066
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
MISC-HARDWARE	LOT	.50	.50		50	-	-	-
SH'T-METAL	LOT	2.00	2.00	167	50	-	-	-
TOTALS			26.79	985	706 x 1.5 (1059)		56.200	32.890 ($2.63)

SYSTEM G.A. Transponder

SHEET 2 OF 5

SUB-ASSEMBLY MAIN P.C. BOARD ASS'Y

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
P.C. BOARD	1	6.00	6.00	818				
339	1	1.99	1.99		5	.715	.715	1.422
555	1	.85	.85		5	.715	.715	.607
7404	1	.26	.26		5	.035	.035	.009
7494	4	1.29	5.16		20	.715	2.860	3.689
7805	1	1.05	1.05		5	.715	.715	.751
74121	1	.31	.31		5	.715	.715	.222
74LS00	2	.24	.48		10	.120	.240	.058
74LS02	4	.24	.96		20	.120	.480	.115
74LS73	1	.31	.31		5	.715	.715	.222
74LS74	1	.31	.31		5	.715	.715	.082
74LS221	3	1.13	3.39		15	.715	2.145	2.424
CAPACITOR	7	.19	1.33		35	.160	1.120	.213
CAPACITOR DISC	26	.13	3.38		130	.629	16.354	2.126
CAPACITOR VAR	1	.31	.31		15	8.599	8.599	2.666
RESISTOR	85	.03	2.55		425	.013	1.105	.033
RESISTOR-WIRE WD	2	.25	.50		10	.065	.130	.033
RESISTOR MET'L	13	.16	2.08		65	.046	.598	.096
RESISTOR VAR	7	.35	2.45		105	3.242	22.694	7.943
TRANSISTOR PNP	10	.14	1.40		60	.270	2.700	.378
TRANSISTOR NPN	4	.14	.56		24	.316	1.264	.177
DIODE	14	.35	4.90		70	.155	2.170	.760
TOTALS								

SYSTEM G.A. Transponder

SUB-ASSEMBLY MAIN P.C. BOARD (CON'T)

SHEET 3 OF 5

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
CHOKE	4	.18	.72		40	.212	.848	.153
TRANSFORMER-POW	1	8.12	8.12		215	1.500	1.500	12.180
TOTALS			49.37	818	1294		69.132	36.359 (2.37)

SYSTEM G.A. TRANSPONDER

SUB-ASSEMBLY CHASSIS

SHEET 4 OF 5

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL.RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
BOTTOM COVER	1			48	20	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
REAR PANEL	1			184	20	-	-	-
SIDE PANEL	2			234	32	-	-	-
PANEL P.C. BOARD	1	6.60	6.60		100	-	-	-
PUSH BUTTON SW	1	.50	.50		25	18.596	18.596	9.298
LAMP	4	.62	2.48		100	25.856	103.424	64.123
TRANS CAVITY	1	30.00	30.00		225	200.00	200.000	6000.00
PRESELECTOR	1	7.50	7.50		50	1.180	1.180	8.850
LOW PASS FILTER	1	3.00	3.00		25	11.844	11.844	35.532
MISC-HARDWARE	LOT	2.50	2.50		100	-	-	-
MATERIAL	LOT	4.00	4.00		200	-	-	-
TOTALS			69.72	581	941		335.044	6117.803 ($82.17)

SYSTEM G.A. TRANSPONDER

SUB-ASSEMBLY ASS'Y & TEST

SHEET 5 OF 5

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
P.C. BOARD	1				50	-	-	-
FRONT PANEL	1				50	-	-	-
CAVITY	1				25	-	-	-
RECEIVER	1				25	-	-	-
ALIGNMENT	-				250	-	-	-
BURN-IN	-				500	-	-	-
TEST	-				1000	-	-	-
TOTALS					1900			

AD-A112 957 ARINC RESEARCH CORP ANNAPOLIS MD F/G 17/7
COST ANALYSIS OF THE DISCRETE ADDRESS BEACON SYSTEM FOR THE LOW--ETC(U)
SEP 81 S KOWALSKI, K PETER, A SCHUST, D SWANN DOT-FA76WA-3788
UNCLASSIFIED 1326-01-15-2529 DOT/FAA/RD-81/61 NL

2 OF 4
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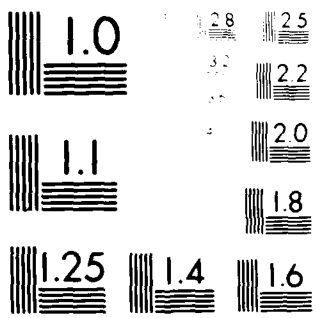

MICROCOPY RESOLUTION TEST CHART

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APPENDIX A-2

BASIC DABS
(Discrete Version)

SYSTEM DABS Transponder SHEET 1 OF 8

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
1N277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.3[illegible]		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE, SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SHEET 2 OF 8

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 8

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER SHEET 4 OF 8

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	2	1.33	2.66		16	1.970	3.940	5.240
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SFM 30	2	.80	1.60		10	.155	.310	.248
TRSTR. SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	3	.84	2.52		18	.629	1.887	1.585
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.664	1.328	1.116
PC. BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			19.89	985	436 x 1.5 (654)		27.64	33.721 ($5.49)

SYSTEM Baseline DABS Transponder

SHEET 5 OF 8

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	2	.24	.48		16	.120	.240	.058
7402	3	.24	.72		24	.120	.360	.086
7404	10	.26	2.60		80	.715	7.150	1.859
7407	1	.32	.32		8	.715	.715	.229
7408	20	.26	5.20		160	.120	2.400	.624
7432	7	.26	1.82		56	.120	.840	.218
7478	9	.31	2.79		117	.715	6.435	1.995
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.030
74154	1	1.07	1.07		12	.715	.715	.765
74157	8	.72	5.76		80	.715	5.720	4.11[illegible]
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.79	1.58		20	.715	1.430	1.130
74198	4	1.43	5.72		48	.715	2.860	4.090
74LS21	7	.24	1.68		56	.060	.420	.101
74S271	1	1.29	1.29		12	.715	.715	.922
TOTALS								

SYSTEM Baseline DABS Transponder

SHEET 6 OF 8

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MC 8504P	6	5.75	34.50		48	.715	4.290	24.668
DM 75S29	4	1.29	5.16		32	.715	2.860	3.689
MC 556	2	.85	1.70		10	.715	1.430	1.216
TRSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
CAP Disc	10	.13	1.30		50	.291	2.910	.378
PC Board	2	10.00	20.00	1776	100	-	-	-
Misc. Hdw.	Lot	.50	.50		50			
TOTALS			158.97	1776	2054 x 2 (4108)		87.505	95.802 (4.93)

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC Connectors	5	1.26	6.30		75	-	-	-
TOTALS			90.80	1349	1808		429.527	6185.267 (64.80)

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Enc/Dec #1	1				25			
Enc/Dec #2	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				1000			
TOTALS					2550			

APPENDIX A-3

BASIC DABS WITH ANTENNA DIVERSITY

(Discrete Version)

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder SHEET 2 OF 8

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 8

SUB-ASSEMBLY DPSK Demod./PPM. Mod. & Diversity Switch

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	2	.26	.52		16	.120	.240	.062
7420	1	.31	.31		8	.715	.715	.222
74121	2	.31	.62		16	.715	1.430	.443
74132	1	.64	.64		8	.120	.120	.077
67121	2	1.24	2.48		12	.715	1.430	1.773
2N2857	1	1.10	1.10		6	.316	.316	.348
2N3646	2	.68	1.36		12	.316	.632	.430
2N3866	1	1.24	1.24		6	.316	.316	.392
HP2800	2	.42	.84		2	.155	.310	.130
LM318H	1	2.10	2.10		8	.715	.715	1.502
MPSA 56	4	.17	.68		24	.316	1.264	.215
CAP DISC	34	.13	4.42		170	.291	9.894	1.286
CAP VAR	1	.23	.23		15	8.599	8.599	1.978
RESISTOR, FC	40	.03	1.20		200	.013	.520	.016
COIL	4	.28	1.12		24	.069	.276	.077
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	2	.42	.84		30	.664	1.328	.557
PC. BOARD	1	2.00	2.00	818	25	-	-	-
MISC. HDW.	LOT	.50	.50		50	-	-	-
TOTALS			27.46	818	700 x 1.5 (1050)		29.535	13.269 (2.02)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	2	1.33	2.66		16	1.970	3.940	5.240
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR. SI	1	.15	.15		6	.316	.316	.047
DIODE. SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	3	.84	2.52		18	.629	1.887	1.585
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.664	1.328	1.116
PC. BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			19.89	985	436 x 1.5 (654)		27.64	33.721 ($5.49)

SYSTEM Baseline DABS Transponder

SHEET 5 OF 8

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	2	.24	.48		16	.120	.240	.058
7402	3	.24	.72		24	.120	.360	.086
7404	10	.26	2.60		80	.715	7.150	1.859
7407	1	.32	.32		8	.715	.715	.229
7408	20	.26	5.20		160	.120	2.400	.624
7432	7	.26	1.82		56	.120	.840	.218
7478	9	.31	2.79		117	.715	6.435	1.995
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.030
74154	1	1.07	1.07		12	.715	.715	.765
74157	8	.72	5.76		80	.715	5.720	4.118
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.79	1.58		20	.715	1.430	1.130
74198	4	1.43	5.72		48	.715	2.860	4.090
74LS21	7	.24	1.68		56	.060	.420	.101
74S271	1	1.29	1.29		12	.715	.715	.922
TOTALS								

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MC 8504P	6	5.75	34.50		48	.715	4.290	24.668
DM 75S29	4	1.29	5.16		32	.715	2.860	3.689
MC 556	2	.85	1.70		10	.715	1.430	1.216
TRSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
CAP Disc	10	.13	1.30		50	.291	2.910	.378
PC Board	2	10.00	20.00	1776	100	-	-	-
Misc. Hdw.	Lot	.50	.50		50			
TOTALS			158.97	1776	2054 x 2 (4108)		87.505	95.802 (4.93)

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	2	30.00	60.00		450	200.000	400.000	12000.000
PRESELECTOR	2	7.50	15.00		100	1.18	2.360	17.700
L.P. FILTER	2	3.00	6.00		50	11.844	23.688	71.064
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDWE.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	2	1.23	2.46		30	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	6	1.26	7 56		90	-	-	-
TOTALS			133.79	1349	2138		642.551	12,229.649 (85.65)

SYSTEM ______

SUB-ASSEMBLY ASSY. & Test

SHEET 8 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	2				100			
Mod/Demod	1				75			
Pwr Supply	1				150			
Enc/Dec #1	1				25			
Enc/Dec #2	1				25			
Cavity	2				200			
Preselector	2				100			
LP Filter	2				100			
Front Panel	1				25			
Covers	Lot				25			
Alignment					500			
Burn-In	-				600			
Test	-				1000			
TOTALS					2925			

APPENDIX A-4

BASIC DABS WITH 21.5 dBW AT ANTENNA

(Discrete Version)

SYSTEM DABS Transponder SHEET 1 OF 8

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier (Cont'd)

SHEET 2 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSP	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	[illegible]	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	[illegible]	[illegible]	-	-	-
TOTALS			44.25	985	907 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 8

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	4	.84	3.36		24	.629	2.516	2.113
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			20.73	985	442 x 1.5 (663)		28.269	34.249 (5.45)

SYSTEM Baseline DABS Transponder

SHEET 5 OF 8

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	2	.24	.48		16	.120	.240	.058
7402	3	.24	.72		24	.120	.360	.086
7404	10	.26	2.60		80	.715	7.150	1.859
7407	1	.32	.32		8	.715	.715	.229
7408	20	.26	5.20		160	.120	2.400	.624
7432	7	.26	1.82		56	.120	.840	.218
7478	9	.31	2.79		117	.715	6.435	1.995
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.030
74154	1	1.07	1.07		12	.715	.715	.765
74157	8	.72	5.76		80	.715	5.720	4.118
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.79	1.58		20	.715	1.430	1.130
74198	4	1.43	5.72		48	.715	2.860	4.090
741021	7	.24	1.68		56	.060	.420	.101
748271	1	1.29	1.29		12	.715	.715	.922
TOTALS								

SYSTEM Baseline DABS Transponder

SHEET 6 OF 8

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MC 8504P	6	5.75	34.50		48	.715	4.290	24.658
DM 75S29	4	1.29	5.16		32	.715	2.860	3.689
MC 556	2	.85	1.70		10	.715	1.430	1.216
TRSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
CAP Disc	10	.13	1.30		50	.291	2.910	.378
PC Board	2	10.00	20.00	1776	100	-	-	-
Misc. Hdw.	Lot	.50	.50		50			
TOTALS			158.97	1776	2054 x 2 (4108)		87.505	95.802 (4.93)

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC Connectors	5	1.26	6.30		75	-	-	-
TOTALS			90.80	1349	1808		429.527	6185.267 (64.80)

SYSTEM ____________

SHEET 8 OF 8

SUB-ASSEMBLY ASSY. & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Enc/Dec #1	1				25			
Enc/Dec #2	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				1000			
TOTALS					2550			

APPENDIX A-5

DABS WITH COMM A AND B

(Discrete Version)

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
1N277	1	.36	.36		5	.715	.715	.257
1N4151	3	.30	.90		15	.150	.450	.135
1N4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE, SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SHEET 2 OF 8

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder SHEET 3 OF 8

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.402	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SHEET 4 OF 8

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS Transponder

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	3	.24	.72		24	.120	.360	.086
7402	4	.24	.96		32	.120	.480	.115
7404	10	.26	2.60		80	.715	7.150	1.859
7407	1	.32	.32		8	.715	.715	.229
7408	20	.26	5.20		160	.120	2.400	.624
7432	7	.26	1.82		56	.120	.840	.218
7478	9	.31	2.79		117	.715	6.435	1.995
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74126	1	.44	.44		8	.715	.715	.315
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.030
74154	1	1.07	1.07		12	.715	.715	.765
74157	9	.72	6.48		90	.715	6.435	4.633
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.49	1.58		20	.715	1.430	1.130
74198	4	1.43	5.72		48	.715	2.860	4.090
74LS21	7	.24	1.68		56	.060	.420	.101
TOTALS								

SYSTEM ______

SHEET 6 OF 8

SUB ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
74S271	1	1.29	1.29		100	.715	.715	.922
MC8504P	6	5.75	34.50		48	.715	4.290	24.668
MM74C910	1	7.40	7.40		8	.715	.715	5.291
DM75S29	5	1.29	6.45		40	.715	3.575	4.612
MC556	2	.85	1.70		10	.715	1.430	1.216
TRSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
CAP DISC	10	.13	1.30		50	.291	2.910	.378
PC Board	2	10.00	20.00	1776	100	-	-	-
Misc. Hdw.	Lot	1.50	1.50		50	-	-	-
TOTALS			170.30	1776	2132 x 2 (4264)		90.605	102.903 (5.11)

'STEM Baseline DABS Transponder

SHEET 7 OF 8

B-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS MANUFACTURING	LABOR HOURS PER 1000 UNITS ASSEMBLY	UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC Connectors	5	1.26	6.30		75	-	-	-
TOTALS			90.80	1349	1808		429.527	6185.267 (64.80)

SYSTEM ____________

SHEET 8 OF 8

SUB-ASSEMBLY ASSY. & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Enc/Dec #1	1				25			
Enc/Dec #2	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	-				500			
Burn-In	-				500			
Test	-				1000			
TOTALS					2550			

APPENDIX A-6

DABS WITH COMM A AND B AND ATARS
(Discrete Version)

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier

SHEET 1 OF 10

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS MANUFACTURING	LABOR HOURS PER 1000 UNITS ASSEMBLY	UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
1N277	1	.36	.36		5	.715	.715	.257
1N4151	3	.30	.90		15	.150	.450	.135
1N4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SP86797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder SHEET 2 OF 10

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 10

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER SHEET 4 OF 10

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS Transponder

SHEET 5 OF 10

SUB-ASSEMBLY Decoder/Encoder

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	3	.24	.72		24	.120	.360	.086
7402	4	.24	.96		32	.120	.480	.115
7404	10	.26	2.60		80	.715	7.150	1.859
7407	1	.32	.32		8	.715	.715	.229
7408	20	.26	5.20		160	.120	2.400	.624
7432	7	.26	1.82		56	.120	.840	.218
7478	9	.31	2.79		117	.715	6.435	1.995
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74126	1	.44	.44		8	.715	.715	.315
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.030
74154	1	1.07	1.07		12	.715	.715	.765
74157	9	.72	6.48		90	.715	6.435	4.633
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.49	1.58		20	.715	1.430	1.130
74198	4	1.43	5.72		48	.715	2.860	4.090
74LS21	7	.24	1.68		56	.060	.420	.101
TOTALS								

SYSTEM ____________

SUB-ASSEMBLY Decoder/Encoder

SHEET 6 OF 10

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
74S271	1	1.29	1.29		100	.715	.715	.922
MC8504P	6	5.75	34.50		48	.715	4.290	24.668
MM74C910	1	7.40	7.40		8	.715	.715	5.291
DM75S29	5	1.29	6.45		40	.715	3.575	4.612
MC556	2	.85	1.70		10	.715	1.430	1.216
TRSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
CAP DISC	10	.13	1.30		50	.291	2.910	.378
PC Board	2	10.00	20.00	1776	100	-	-	-
Misc. Hdw.	Lot	1.50	1.50		50	-	-	-
TOTALS			170.30	1776	2132 x 2 (4264)		90.605	102.903 (5.11)

SYSTEM DABS TRANSPONDER

SHEET 7 OF 10

SUB-ASSEMBLY ATARS

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	5	.24	1.20		40	.120	.600	.144
7404	4	.24	.96		32	.715	2.860	.686
7408	10	.26	2.60		80	.120	1.200	.312
7416	2	.27	.54		16	.120	.240	.065
7417	7	.27	1.89		56	.120	.840	.227
7432	7	.26	1.82		56	.120	.840	.218
7447A	8	.86	6.88		64	.715	5.720	4.920
7478	8	.31	2.48		64	.715	5.720	1.773
74138	1	.65	.65		8	.715	.715	.465
74157	1	.72	.72		8	.715	.715	.515
74164	7	.93	6.51		56	.715	5.005	4.655
74166	8	.93	7.44		64	.715	4.720	5.320
74LS21	2	.24	.48		16	.060	.120	.029
556	1	.96	.96		8	.715	.715	.686
SN74186	2	11.43	22.86		16	.715	1.430	16.345
CAP DISC	10	.13	1.30		80	.291	2.910	.378
RESISTOR	50	.03	1.50		400	.013	.650	.020
LED DLY 6661	12	2.07	24.84		60	.715	8.580	17.761
LED HLMP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED CQV36-3	16	.29	4.64		80	.715	11.44	3.318
LED CQV 38-3	8	.30	2.40		40	.715	4.720	1.716
TOTALS								

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY ATARS

SHEET 8 OF 10

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
P.C. BOARD	2	4.00	8.00	1636	50	-	-	-
MISC. HDW.	LOT	.50	.50		50	-	-	-
TOTALS			104.67	1636	1354 x 1.5 (2031)		63.170	62.056 (4.42)

SYSTEM DABS Transponder

SHEET 9 OF 10

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35,532
POTENTIOMETER	1	.35	.35		15	.664	.644	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	4	.62	2.48		60	25.856	103.424	64,123
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2,143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
THUMBWHEEL	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	7	1.26	8.82		105	-	-	-
TOTALS			86.46	531	1698		351.959	6137.175 (78.47)

SYSTEM DABS with COMM A&B and ATARS

SUB-ASSEMBLY ASSY. & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Logic Bd #1	1				25			
Logic Bd. #2	1				25			
ATARS #1	1				25			
ATARS #2	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				200			
Covers	Lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				1500			
TOTALS					3275			

APPENDIX A-7

DABS WITH COMM A AND B, ATARS AND BCAS INTERFACE

(Discrete Version)

SYSTEM DABS Transponder SHEET 1 OF 10

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SHEET 2 OF 10

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder SHEET 3 OF 10

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM Baseline Dabs with Comm A & B and BCAS Interface

SHEET 5 OF 10

SUB-ASSEMBLY Logic Boards

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	15	.24	3.60		40	.120	.60	.432
7402	4	.24	.96		32	.120	.480	.115
7404	12	.26	3.12		96	.715	8.580	2.230
7407	1	.32	.32		8	.715	.715	.229
7408	24	.26	6.24		192	.120	2.880	.749
7432	9	.26	2.34		72	.120	.96	.281
7478	12	.31	3.72		156	.715	8.580	2.660
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74126	1	.44	.44		8	.715	.715	.315
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.030
74154	1	1.07	1.07		12	.715	.715	.765
74157	9	.72	6.48		90	.715	6.435	4.633
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	33	.93	30.69		330	.715	23.595	21.943
74174	2	.79	1.58		20	.715	1.430	1.130
74198	4	1.43	5.72		48	.715	2.860	4.090
74LS1	7	.24	1.68		56	.060	.420	.101
TOTALS								

SYSTEM

SUB-ASSEMBLY Logic Boards

SHEET 6 OF 10

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
74S271	1	1.29	1.29		100	.715	.715	.922
MC8504P	6	5.75	34.50		48	.715	4.290	24.668
MM74C910	1	7.40	7.40		8	.715	.715	5.291
DM75S29	5	1.29	6.45		40	.715	3.575	4.612
MC556	2	.85	1.70		10	.715	1.430	1.216
TRSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistor	88	.03	2.64		440	.013	1.144	.034
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
CAP DISC	10	.13	1.30		50	.291	2.910	.378
PC Board	3	5.00	15.00	1776	100	-	-	-
Misc. Hdw.	Lot	1.50	1.50		50	-	-	-
TOTALS			178.63	2454	2381 x 2 (4762)		100.86	110.152 (4.92)

SYSTEM DABS TRANSPONDER

SHEET 7 OF 10

SUB-ASSEMBLY ATARS

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	5	.24	1.20		40	.120	.600	.144
7404	4	.24	.96		32	.715	2.860	.686
7408	10	.26	2.60		80	.120	1.200	.312
7416	2	.27	.54		16	.120	.240	.065
7417	7	.27	1.89		56	.120	.840	.227
7432	7	.26	1.82		56	.120	.840	.218
7447A	8	.86	6.88		64	.715	5.720	4.920
7478	8	.31	2.48		64	.715	5.720	1.773
74138	1	.65	.65		8	.715	.715	.465
74157	1	.72	.72		8	.715	.715	.515
74164	7	.93	6.51		56	.715	5.005	4.655
74166	8	.93	7.44		64	.715	4.720	5.320
74LS21	2	.24	.48		16	.060	.120	.029
556	1	.96	.96		8	.715	.715	.686
SN74186	2	11.43	22.86		16	.715	1.430	16.345
CAP DISC	10	.13	1.30		80	.291	2.910	.378
RESISTOR	50	.03	1.50		400	.013	.650	.020
LED DLY 6661	12	2.07	24.84		60	.715	8.580	17.761
LED HLMP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED CQV36-3	16	.29	4.64		80	.715	11.44	3.318
LED CQV 38-3	8	.30	2.40		40	.715	4.720	1.716
TOTALS								

SYSTEM DABS TRANSPONDER

SHEET 8 OF 10

SUB-ASSEMBLY ATARS

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
P.C. BOARD,	2	4.00	8.00	1636	50	-	-	-
MISC. HDW.	LOT	.50	.50		50	-	-	-
TOTALS			104.67	1636	1354 x 1.5 (2031)		63.170	62.056 (4.42)

SYSTEM BASELINE DABS TRANSPONDER

SUB-ASSEMBLY Chassis & Enclosure

SHEET 9 OF 10

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	4	.62	2.48		60	25.856	103.424	64.123
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
THUMBWHEEL	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	8	1.26	10.08		120	-	-	-
TOTALS			87.72	531	1713		351.959	6137.175 (78.47)

SYSTEM DABS TRANSPONDER

SHEET 10 OF 10

SUB-ASSEMBLY ASSY. & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Logic Board 1	1				25			
Logic Board 2	1				25			
Logic Board 3	1				25			
ATARS Board 1	1				25			
ATARS Board 2	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				200			
Covers	Lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				1500			
TOTALS					3300			

APPENDIX A-8

DABS WITH COMM A, B, AND C
(Discrete Version)

SYSTEM UABS Transponder

SHEET 1 OF 8

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier (Cont'd)

SHEET 2 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder SHEET 3 OF 8

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

SHEET 4 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.18)

SYSTEM DABS with ELM UPLINK

SHEET 5 OF 8

SUB-ASSEMBLY Logic Processor

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	3	.24	.72		24	.120	.360	.086
7402	4	.24	.96		32	.120	.480	.115
7404	11	.26	2.86		88	.715	7.865	2.04
7407	1	.32	.32		8	.715	.715	.229
7408	24	.26	6.24		192	.120	2.88	.749
7432	7	.26	1.82		56	.120	.840	.218
7478	11	.31	3.41		143	.715	7.865	2.438
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74126	1	.44	.44		8	.715	.715	.315
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.03
74154	1	1.07	1.07		12	.715	.715	.765
74157	9	.72	6.48		90	.715	6.435	4.633
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.79	1.58		20	.715	1.430	1.13
74198	4	1.43	5.72		48	.715	2,860	4.090
74LS21	7	.24	1.68		56	.060	.420	.101
TOTALS								

SYSTEM DABS with ELM UPLINK

SUB-ASSEMBLY Logic Processor

SHEET 6 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
74S271	1	1.29	1.29		100	.715	.715	.922
MC8504P	6	5.75	34.50		48	.715	4.290	24.668
MM74C910	1	7.40	7.40		8	.715	.715	5.291
DM75S29	5	1.29	6.45		40	.715	3.575	4.612
NC556	2	.85	1.70		10	.715	1.430	1.216
8048	1	7.50	7.50		20	.507	.507	3.803
MCM4027AC4	1	3.80	3.80		16	.715	.715	2.717
TRSTR NPN	6	.14	.84		36	.316	1.339	.040
Resistor	103	.03	3.09		515	.013	1.599	.048
Crystal	2	10.00	20.00		30	1.500	3.000	30.000
CAP DISC	20	.13	2.60		100	.291	5.82	.757
PC Board	3	5.00	15.00	2664	100			
Misc. Hdw.	lot	1.50	1.50		50			
TOTALS			192.77	2664	2482 x 2 (4964)		100.487	125.557 (5.62)

SYSTEM Baseline DABS Transponder

SHEET 7 OF 8

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180 992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	6	1.26	7.56		90			
TOTALS			92.06	1349	1823		429.527	6185.267 (64.80)

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Logic BD 1	1				25			
Logic BD 2	1				25			
Logic BD 3	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				2000			
TOTALS					3575			

APPENDIX A-9

DABS WITH COMM A, B, AND C AND ATARS

(Discrete Version)

SYSTEM DABS Transponder SHEET 1 OF 10

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 10

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

SHEET 4 OF 10

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS with ELM UPLINK

SHEET 5 OF 10

SUB-ASSEMBLY Logic Processor

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	3	.24	.72		24	.120	.360	.086
7402	4	.24	.96		32	.120	.480	.115
7404	11	.26	2.86		88	.715	7.865	2.04
7407	1	.32	.32		8	.715	.715	.229
7408	24	.26	6.24		192	.120	2.88	.749
7432	7	.26	1.82		56	.120	.840	.218
7478	11	.31	3.41		143	.715	7.865	2.438
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2.145	1.973
74126	1	.44	.44		8	.715	.715	.315
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.03
74154	1	1.07	1.07		12	.715	.715	.765
74157	9	.72	6.48		90	.715	6.435	4.633
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.79	1.58		20	.715	1.430	1.13
74198	4	1.43	5.72		48	.715	2,860	4.090
74LS21	7	.24	1.68		56	.060	.420	.101
TOTALS								

SYSTEM DABS with ELM UPLINK

SHEET 6 OF 10

SUB-ASSEMBLY Logic Processor

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
74S271	1	1.29	1.29		100	.715	.715	.922
MC8504P	6	5.75	34.50		48	.715	4.290	24.668
MM74C910	1	7.40	7.40		8	.715	.715	5.291
DM75S29	5	1.29	6.45		40	.715	3.575	4.612
NC556	2	.85	1.70		10	.715	1.430	1.216
8048	1	7.50	7.50		20	.507	.507	3.803
MCM4027AC4	1	3.80	3.80		16	.715	.715	2.717
TRSTR NPN	6	.14	.84		36	.316	1.339	.040
Resistor	103	.03	3.09		515	.013	1.599	.048
Crystal	2	10.00	20.00		30	1.500	3.000	30.000
CAP DISC	20	.13	2.60		100	.291	5.82	.757
PC Board	3	5.00	15.00	2664	100			
Misc. Hdw.	Lot	1.50	1.50		50			
TOTALS			192.77	2664	2482 x 2 (4964)		100.487	125.557 (5.62)

SYSTEM DABS TRANSPONDER

SHEET 7 OF 10

SUB-ASSEMBLY ATARS

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	5	.24	1.20		40	.120	.600	.144
7404	4	.24	.96		32	.715	2.860	.686
7408	10	.26	2.60		80	.120	1.200	.312
7416	2	.27	.54		16	.120	.240	.065
7417	7	.27	1.89		56	.120	.840	.227
7432	7	.26	1.82		56	.120	.840	.218
7447A	8	.86	6.88		64	.715	5.720	4.920
7478	8	.31	2.48		64	.715	5.720	1.773
74138	1	.65	.65		8	.715	.715	.465
74157	1	.72	.72		8	.715	.715	.515
74164	7	.93	6.51		56	.715	5.005	4.655
74166	8	.93	7.44		64	.715	4.720	5.320
74LS21	2	.24	.48		16	.060	.120	.029
556	1	.96	.96		8	.715	.715	.686
SN74186	2	11.43	22.86		16	.715	1.430	16.345
CAP DISC	10	.13	1.30		80	.291	2.910	.378
RESISTOR	50	.03	1.50		400	.013	.650	.020
LED DLY 6661	12	2.07	24.84		60	.715	8.580	17.761
LED HLMP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED CQV36-3	16	.29	[illegible].64		80	.715	11.44	3.318
LED CQV 38-3	8	.30	2.40		40	.715	4.720	1.716
TOTALS								

SYSTEM DABS TRANSPONDER

SHEET 8 OF 10

SUB-ASSEMBLY ATARS

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
P.C. BOARD	2	4.00	8.00	1636	50	-	-	-
MISC. HDW.	LOT	.50	.50		50	-	-	-
TOTALS			104.67	1636	1354 x 1.5 (2031)		63.170	62.056 (4.42)

SYSTEM BASELINE DABS TRANSPONDER

SHEET 9 OF 10

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	4	.62	2.48		60	25.856	103.424	64.123
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
THUMBWHEEL	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	8	1.26	10.08		120	-	-	-
TOTALS			87.72	531	1713		351.959	6137.175 (78.47)

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

SHEET 10 OF 10

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Logic Bd #1	1				25			
Logic Bd #2	1				25			
Logic Bd #3	1				25			
ATARS Bd #1	1				25			
ATARS Bd #2	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				200			
Covers	Lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				2500			
TOTALS					4300			

APPENDIX A-10

DABS WITH COMM A, B, C, AND D

(Discrete Version)

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE, SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SHEET 2 OF 9

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 9

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS MANUFACTURING	LABOR HOURS PER 1000 UNITS ASSEMBLY	UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY - Comm A/B, C/D

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE110C	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	6	.35	2.10		30	.155	.930	.326
RESISTOR PC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
TYA - 1175.11	2	2.51	5.02		80	.629	1.258	3.158
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	3.55	3.55		40	8.998	8.998	31.943
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			23.30	985	479 x 115 (719)		27.364	45.251 (7.44)

SYSTEM DABS with Com A, B, C and D

SHEET 5 OF 9

SUB-ASSEMBLY Logic Processor

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	3	.24	.72		24	.120	.360	.086
7402	4	.24	.96		32	.120	.480	.115
7404	14	.26	3.64		112	.715	10.01	2.603
7407	1	.32	.32		8	.715	.715	.229
7408	28	.26	7.28		224	.120	3.360	.874
7432	9	.26	2.34		72	.120	.840	.281
7478	13	.31	4.03		169	.715	9.295	2.882
7485	9	.84	7.56		72	.715	6.435	5.405
7486	6	.55	3.30		48	.120	.720	.396
7491A	3	.92	2.76		24	.715	2,145	1.973
74126	1	.44	.44		8	.715	.715	.315
74138	1	.65	.65		8	.715	.715	.465
74150	1	.97	.97		10	.715	.715	.694
74153	2	.72	1.44		16	.715	1.430	1.03
74154	1	1.07	1.07		12	.715	.715	.765
74157	9	.72	6.48		90	.715	6.435	4.633
74161	9	.54	4.86		90	.715	6.435	3.475
74164	7	.93	6.51		56	.715	5.005	4.655
74166	25	.93	23.25		250	.715	17.875	16.264
74174	2	.79	1.58		20	.715	1.430	1.13
74198	4	1.43	5.72		48	.715	2.860	4.090
74LS21	7	.24	1.68		56	.060	.420	.101
TOTALS								

SYSTEM DABS with Comm A, B, C and D

SUB-ASSEMBLY Logic Processor

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
74S271	1	1.29	1.29		100	.715	.715	.922
MC8504P	6	5.75	34.50		48	.715	4.290	24.668
MM74C910	1	7.40	7.40		8	.715	.715	5.291
DM75S29	5	1.29	6.45		40	.715	3.575	4.612
NC556	2	.85	1.70		10	.715	1.430	1.216
8039-11	1	18.65	18.65		20	.507	.507	9.456
8156	1	3.80	3.80		16	.715	.715	2.717
TRSTR NPN	6	.14	.84		36	.316	1.896	.265
RESISTOR	123	.03	3.69		615	.013	1.599	.048
CRYSTAL	2	10.00	20.00		30	1.500	3.000	30.000
CAP DISC	30	.13	3.90		150	.291	8.73	1.135
PC BOARD	3	5.00	15.00	2644	100			
TOTALS			214.18	2644	2622 x 2 (5244)		108.112	132.728 (5.52)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER AMPLIFIER

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
SD1522	1	13.10	13.10		50	17.010	17.010	222.831
SD1526	1	14.80	14.80		50	17.010	17.010	251.748
SD1530	1	22.50	22.50		50	35.215	35.215	792.338
SD1538	1	39.60	39.60		50	176.077	176.077	6972.649
CAPS-DISC	14	.13	1.82		70	.291	4.074	.530
COILS	8	.12	.96		40	.069	.552	.066
RESISTORS	5	.03	.15		25	.013	.065	.002
TVA-1319.9	1	2.85	2.85		40	.629	.629	1.793
TVA-1318.2	1	2.34	2.34		40	.629	.629	1.472
SUBSTRATE PC	1	15.00	15.00	818	50	-	-	-
RF CONN	1	1.35	1.35		25	-	-	-
ENCLOSURE	1	2.00	2.00	167	44	-	-	-
COVER	1	0.50	.50	42	22	-	-	-
MISC. HDW	LOT	0.50	.50		50	-	-	-
TOTALS			117.47	1027	606		251.261	8243.429 (147.64)

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

SHEET 8 OF 9

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.644	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	6	1.26	7.56		90			
TOTALS			62.06	1349	1598		229.527	185.267 3.63

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

SHEET 9 OF 9

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor #1	1				25			
Processor #2	1				25			
Processor #3	1				25			
Power Amp	1				125			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	-				500			
Burn-In	-				500			
Test	-				2000			
TOTALS					3600			

APPENDIX A-11

BASIC DABS

(LSI Version)

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SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSP	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 7

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR PC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	2	1.33	2.66		16	1.970	3.940	5.240
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR. SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	3	.84	2.52		18	.629	1.887	1.585
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.664	1.328	1.116
PC. BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			19.89	985	436 x 1.5 (654)		27.64	33.721 ($5.49)

SYSTEM Baseline DABS Transponder

SHEET 5 OF 7

SUB-ASSEMBLY Main PC Board

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.62		16	.715	1.430	.443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	.014
MC 556	2	.85	1.70		10	.715	1.430	1.216
LSI	3	10.00	30.00		60	.317	.951	9.510
LSI Timing	1	5.00	5.00		20	.211	.211	1.055
TSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistors	94	.03	2.82		470	.013	1.222	.037
Capacitors	10	.13	1.30		50	.629	6.290	.818
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
PC Board	1	5.00	5.00	818	25	-	-	-
Misc. Hdw.	Lot	.50	.50		50	-	-	-
LSI Socket	4	1.25	5.00		80	-	-	-
TOTALS			73.52	818	1016 x 2 (2032)		23.345	33.995 (6.55)

SYSTEM Baseline DABS Transponder SHEET 6 OF 7

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60			
TOTALS			89.54	1349	1793		429.527	6185.267 (64.80)

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

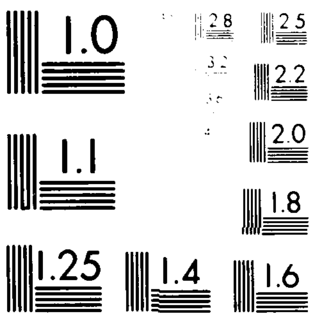
SHEET 7 OF 7

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	-				500			
Burn-In	-				500			
Test	-				1000			
TOTALS					2525			

AD-A112 957 ARINC RESEARCH CORP ANNAPOLIS MD F/G 17/7
COST ANALYSIS OF THE DISCRETE ADDRESS BEACON SYSTEM FOR THE LOW--ETC(U)
SEP 81 S KOWALSKI, K PETER, A SCHUST, D SWANN DOT-FA76WA-3788
UNCLASSIFIED 1326-01-15-2529 DOT/FAA/RD-81/61 NL

3 OF 4

AD A
112957



MICROCOPY RESOLUTION TEST CHART

APPENDIX A-12

BASIC DABS WITH ANTENNA DIVERSITY

(LSI Version)

SYSTEM DABS Transponder

SHEET 1 OF 7

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SHEET 2 OF 7

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder SHEET 3 OF 7

SUB-ASSEMBLY DPSK Demod./PPM. Mod. & Diversity Switch

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	2	.26	.52		16	.120	.240	.062
7438	1	.31	.31		8	.715	.715	.222
74121	2	.31	.62		16	.715	1.430	.443
74132	1	.64	.64		8	.120	.120	.077
67121	2	1.24	2.48		12	.715	1.430	1.773
2N2857	1	1.10	1.10		6	.316	.316	.348
2N3646	2	.68	1.36		12	.316	.632	.430
2N3866	1	1.24	1.24		6	.316	.316	.392
HP2800	2	.42	.84		2	.155	.310	.130
LM318H	1	2.10	2.10		8	.715	.715	1.502
MPSA 56	4	.17	.68		24	.316	1.264	.215
CAP DISC	34	.13	4.42		170	.291	9.894	1.286
CAP VAR	1	.23	.23		15	8.599	8.599	1.978
RESISTOR, FC	40	.03	1.20		200	.013	.520	.016
COIL	4	.28	1.12		24	.069	.276	.077
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	2	.42	.84		30	.664	1.328	.557
PC. BOARD	1	2.00	2.00	818	25	-	-	-
MISC. HDW.	LOT	.50	.50		50	-	-	-
TOTALS			27.46	818	700 x 1.5 (1050)		29.535	13.269 (2.02)

SYSTEM DABS TRANSPONDER   SHEET 4 OF 7

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	2	1.33	2.66		16	1.970	3.940	5.240
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR. SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	3	.84	2.52		18	.629	1.887	1.585
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.664	1.328	1.116
PC. BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			19.89	985	436 x 1.5 (654)		27.64	13.721 ($5.49)

SYSTEM Baseline DABS Transponder

SHEET 5 OF 7

SUB-ASSEMBLY Main PC Board

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.62		16	.715	1.430	.443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	.014
NC 556	2	.85	1.70		10	.715	1.430	1.216
LSI	3	10.00	30.00		60	.317	.951	9.510
LSI Timing	1	5.00	5.00		20	.211	.211	1.055
TSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistors	94	.03	2.82		470	.013	1.222	.037
Capacitors	10	.13	1.30		50	.629	6.290	.818
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
PC Board	1	5.00	5.00	818	25	-	-	-
Misc. Hdw.	Lot	.50	.50		50	-	-	-
LSI Socket	4	1.25	5.00		80	-	-	-
TOTALS			73.52	818	1016 x 2 (2032)		23.345	33.995 (6.55)

SYSTEM DABS Transponder

SHEET 6 OF 7

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	2	30.00	60.00		450	200.000	400.000	12000.000
PRESELECTOR	2	7.50	15.00		100	1.18	2.360	17.700
L.P. FILTER	2	3.00	6.00		50	11.844	23.688	71.064
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDWS.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	2	1.23	2.46		30	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	5	6.30	7.56		75	-	-	-
TOTALS			132.53	1349	2123		642.551	12,229.649 (85.65)

SYSTEM ____________ SHEET 7 OF 7

SUB-ASSEMBLY ASSY. & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	2				100			
Mod/Demod	1				75			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	2				200			
Preselector	2				100			
LP Filter	2				100			
Front Panel	1				25			
Covers	Lot				25			
Alignment	-				600			
Burn-In	-				500			
Test	-				1000			
TOTALS					2900			

APPENDIX A-13

BASIC DABS WITH 21.5 dBW AT ANTENNA

(LSI Version)

SYSTEM DABS Transponder

SHEET 1 OF 7

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
1N277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder SHEET 2 OF 7

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 7

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR PC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS MANUFACTURING	LABOR HOURS PER 1000 UNITS ASSEMBLY	UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR PC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	4	.84	3.36		24	.629	2.516	2.113
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			20.73	985	442 x 1.5 (663)		28.269	34.249 (5.45)

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Main PC Board

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.62		16	.715	1.430	.443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	.014
NC 556	2	.85	1.70		10	.715	1.430	1.216
LSI	3	10.00	30.00		60	.317	.951	9.510
LSI Timing	1	5.00	5.00		20	.211	.211	1.055
TSTR NPN	6	.14	.84		36	.316	1.896	.265
Resistors	94	.03	2.82		470	.013	1.222	.037
Capacitors	10	.13	1.30		50	.629	6.290	.818
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
PC Board	1	5.00	5.00	818	25	-	-	-
Misc. Hdw.	Lot	.50	.50		50	-	-	-
LSI Socket	4	1.25	5.00		80	-	-	-
TOTALS			73.52	818	1016 x 2 (2032)		23.345	33.995 (6.55)

SYSTEM Baseline DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

SHEET 6 OF 7

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60			
TOTALS			89.54	1349	1793		429.527	6185.267 (64.80)

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

SHEET 7 OF 7

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	-				500			
Burn-In	-				500			
Test	-				1000			
TOTALS					2525			

APPENDIX A-14

DABS WITH COMM A AND B

(LSI Version)

SYSTEM DABS Transponder SHEET 1 OF 7

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SHEET 2 OF 7

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 7

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.[illegible]7
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SHEET 4 OF 7

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS with Comm A&B

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS MANUFACTURING	LABOR HOURS PER 1000 UNITS ASSEMBLY	UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.62		16	.715	1.430	.443
74126	1	.44	.44		8	.715	.715	.315
74161	3	.54	1.62		24	.715	2.145	1.158
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	.014
MC 556	2	.85	1.70		10	.715	1.430	1.216
LSI	4	10.00	40.00		80	.317	1.268	12.680
TSTR NPN	6	.14	.84		36	.316	1.896	.265
DM75S29	1	1.29	1.29		8	.715	.715	.922
MM74C910	1	7.40	7.40		8	.715	.715	5.29
Resistors	94	.03	2.82		470	.013	1.22	.037
Capacitors	10	.13	1.30		50	.629	6.290	.818
Crystal	1	10.00	10.00		15	1.500	1.500	15.000
PC Board	1	5.00	5.00	818	25	-	-	-
Misc. Hdw.	Lot	.50	.50		50	-	-	-
LSI Socket	4	1.25	5.00		80	-	-	-
TOTALS			87.65	818	1040 x 2 (2080)		25.596	42.637 (7.50)

SYSTEM Baseline DABS Transponder

SHEET 6 OF 7

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60			
TOTALS			89.54	1349	1793		429.527	6185.267 (64.80)

SYSTEM ______________

SUB-ASSEMBLY ASSY. & Test

SHEET 7 OF 7

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	-				500			
Burn-In	-				500			
Test	-				1000			
TOTALS					2525			

APPENDIX A-15

DABS WITH COMM A AND B AND ATARS

(LSI Version)

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SYSTEM DABS Transponder SHEET 1 OF 8

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SHEET 2 OF 8

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2 [illegible]	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

SHEET 4 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS with Comm A: B and ATARS

SHEET 5 OF 8

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7417	7	.27	1.89		56	.120	.840	.227
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.93		16	.715	1.430	.665
74126	1	.44	.44		8	.715	.715	.315
74161	3	.54	1.62		24	.715	2.145	1.158
74164	6	.93	5.58		48	.715	4.290	3.990
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	0.014
SN7445 LB	3	.95	2.85		24	.715	2.145	2.038
SN7447A	8	.86	6.88		64	.715	5.720	4.920
NC556	3	.85	2.55		15	.715	2.145	1.823
DM75S29	1	1.29	1.29		8	.715	.715	.922
MM 74C910	1	7.40	7.40		8	.715	.715	5.290
TSTR NPN	6	.14	.84		36	.316	1.896	.265
LSI	5	10.00	50.00		100	.317	1.585	15.850
TOTALS								

SYSTEM DABS with Comm A; B and ATARS

SHEET 6 OF 8

SUB-ASSEMBLY Main PC Board

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE *	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
LED DLY6661	12	2.07	24.84		60	.715	8.580	17.761
LED HLMP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED CQV36-3	16	.29	4.64		80	.715	11.444	3.318
LED CQV38-3	8	.30	2.40		40	.715	5.720	1.716
RESISTORS	144	.03	4.32		1152	.013	1.872	0.056
CAPACITORS	20	.13	2.60		160	.291	5.820	.757
CRYSTAL	1	10.00	10.00		15	1.500	1.500	15.00
PC Board	1	5.00	5.00	818	25	-	-	-
Misc. Hdw	Lot	.50	.50		50	-	-	-
LSI Sockets	5	1.25	6.25		100	-	-	-
TOTALS			155.44	818	2259 x 2 (4518)		66.977	83.067 (5.58)

SYSTEM DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.644	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	4	.62	2.48		60	25.856	103.424	64.123
24PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC HDW.	LOT	2.00	2.00		100	-	-	-
SH'T. METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
THUMBWHEEL	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60	-	-	-
PANEL PC BOARD	1	2.00	2.00	818				
TOTALS			84.68	1349	1653		351.959	6137.175 (78.47)

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

SHEET 8 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				200			
Covers	Lot				25			
Alignment	-				500			
Burn-In	-				500			
Test	-				1500			
TOTALS					3200			

APPENDIX A-16

DABS WITH COMM A AND B, ATARS AND BCAS INTERFACE

(LSI Version)

SYSTEM DABS Transponder SHEET 1 OF 8

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE. SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SHEET 2 OF 8

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 8

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
S&T MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS with Comm A: B and ATARS

SHEET 5 OF 8

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7417	7	.27	1.89		56	.120	.840	.227
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.93		16	.715	1.430	.665
74126	1	.44	.44		8	.715	.715	.315
74161	3	.54	1.62		24	.715	2.145	1.158
74164	6	.93	5.58		48	.715	4.290	3.990
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	0.014
SN7445 LB	3	.95	2.85		24	.715	2.145	2.038
SN7447A	8	.86	6.88		64	.715	5.720	4.920
NC556	3	.85	2.55		15	.715	2.145	1.823
DM75S29	1	1.29	1.29		8	.715	.715	.922
MM 74C910	1	7.40	7.40		8	.715	.715	5.290
TSTR NPN	6	.14	.84		36	.316	1.896	.265
LSI	5	10.00	50.00		100	.317	1.585	15.850
TOTALS								

SYSTEM DABS with Comm A: B and ATARS

SHEET 6 OF 8

SUB-ASSEMBLY Main PC Board

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
LED DLY6661	12	2.07	24.84		60	.715	8.580	17.761
LED HLMP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED CQV36-3	16	.29	4.64		80	.715	11.444	3.318
LED CQV38-3	8	.30	2.40		40	.715	5.720	1.716
RESISTORS	144	.03	4.32		1152	.013	1.872	0.056
CAPACITORS	20	.13	2.60		160	.291	5.820	.757
CRYSTAL	1	10.00	10.00		15	1.500	1.500	15.00
PC Board	1	5.00	5.00	818	25	-	-	-
Misc. Hdw	Lot	.50	.50		50	-	-	-
LSI Sockets	5	1.25	6.25		100	-	-	-
TOTALS			155.44	818	2259 x 2 (4518)		66.977	83.067 (5.58)

SYSTEM DABS Transponder

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.644	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	4	.62	2.48		60	25.856	103.424	64.123
24PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC HDW.	LOT	2.00	2.00		100	-	-	-
SH'T. METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
THUMBWHEEL	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60	-	-	-
PANEL PC BOARD	1	2.00	2.00	818				
TOTALS			84.68	1349	1653		351.959	6137.175 (78.47)

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

SHEET 8 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				200			
Covers	Lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				1500			
TOTALS					3200			

APPENDIX A-17

DABS WITH COMM A, B, AND C

(LSI Version)

SYSTEM DABS Transponder

SHEET 1 OF 8

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE, SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier (Cont'd)

SHEET 2 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSP	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 8

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SHEET 4 OF 8

SUB-ASSEMBLY POWER SUPPLY

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		36	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS with Comm A&B and ELM UPLINK

SHEET 5 OF 8

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.62		16	.715	1.430	.443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	.014
NC 556	2	.85	1.70		10	.715	1.430	1.216
74126	1	.44	.44		8	.715	.715	.315
DM75S29	1	1.29	1.29		8	.715	.715	.922
MM74C910	1	7.40	7.40		8	.715	.715	5.290
74157	1	.72	.72		8	.715	.715	.515
8048	1	7.50	7.50		20	.507	.507	3.803
MCM4027AC4	1	3.80	3.80		16	.715	.715	2.717
TOTALS								

SYSTEM DABS with Comm A&B and ELM UPLINK

SHEET 6 OF 8

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
LSI	4	10.00	40.00		80	.317	1.268	12.680
TSTR NPN	6	.14	.84		36	.316	1.896	.265
RESISTORS	109	.03	3.27		485	.013	1.417	.043
CAPACITORS	20	.13	2.60		100	.291	5.820	.757
CRYSTAL	2	10.00	20.00		30	1.500	3.000	30.00
CONNECTOR	1	1.60	1.60		25	-	-	-
P.C. BOARD	1	5.00	5.00	818	25	-	-	-
Misc. Hdw	lot	1.50	1.50		50	-	-	-
LSI Socket	4	1.25	4.00		80	-	-	-
TOTALS			112.42	818	1164 x 2 (2328)		28.758	64.616 (10.11)

SYSTEM Baseline DABS Transponder

SHEET 7 OF 8

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60			
TOTALS			89.54	1349	1793		429.527	6185.267 (64.80)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY ASSY. & Test

SHEET 8 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	lot				25			
Alignment	"				500			
Burn-In	-				500			
Test	-				2000			
TOTALS					3525			

APPENDIX A-18

DABS WITH COMM A, B, AND C AND ATARS

(LSI Version)

SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier

SHEET 1 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE, SI	1	.32	.32		5	.155	.155	.050
CAP. STO.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SHEET 2 OF 8

SUB-ASSEMBLY IF Amplifier (Cont'd)

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder

SHEET 3 OF 8

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY

SHEET 4 OF 8

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
SEM 30	2	.80	1.60		10	.155	.310	.248
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	2	.35	.70		10	.155	.310	.109
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
CAP AL.	6	.84	5.04		35	.629	3.774	3.170
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	2.44	2.44		40	8.998	8.998	21.955
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			22.41	985	425 x 1.5 (678)		29.57	35.306 (5.38)

SYSTEM DABS with Comm A&B, ATARS, and ELM UPLINK

SHEET 5 OF 8

SUB-ASSEMBLY Main PC Board

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	2	.26	.52		16	.120	.240	.062
7417	7	.27	1.89		56	.120	.840	.227
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.93		16	.715	1.430	.665
74126	1	.44	.44		8	.715	.715	.315
74161	3	.54	1.62		24	.715	2.145	1.158
74164	6	.93	5.58		48	.716	4.290	3.990
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	0.014
SN74451LB	3	.95	2.85		24	.715	2.145	2.038
SN7447A	8	.86	6.88		64	.715	5.720	4.920
MC556	3	.85	2.55		15	.715	2.145	1.823
DM75629	1	1.29	1.29		8	.715	.715	.922
MM74C910	1	7.40	7.40		8	.715	.715	5.290
TSTR MPM	6	.14	.84		36	.316	1.896	.265
LSI	5	10.00	50.00		100	.317	1.585	15.850
TOTALS								

SYSTEM DABS with Comm A&B, ATARS, and ELM UPLINK

SHEET 6 OF 8

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
74157	1	.72	.72		8	.715	.715	.515
8048	1	7.50	7.50		20	.507	.507	3.803
MCM4027AC4	1	3.80	3.80		16	.715	.715	2.717
LED DLY6661	12	2.07	24.84		60	.715	8.580	17.761
LED HLMP-2655	2	1.75	3.50		10	.715	1.43	2.503
LED CQV36-3	16	.29	4.64		80	.715	11.444	3.318
LED CQV38-3	8	.30	2.40		40	.715	5.720	1.716
RESISTORS	159	.03	4.77		1272	.013	2.067	.062
CAPACITORS	30	.13	3.90		240	.291	8.73	1.135
CRYSTAL	2	10.00	20.00		30	1.500	3.000	30.000
PC Board	1	5.00	5.00	818	25	-	-	-
Misc. Hrdw.	Lot	.50	.50		50	-	-	-
LSI Sockets	5	1.25	6.25		100	-	-	-
TOTALS			179.21	818	2518 x 2 (5036)		73.519	102.482 (6.27)

SYSTEM DABS Transponder

SHEET 7 OF 8

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
CAVITY	1	30.00	30.00		225	200.000	200.000	6000.000
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.644	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	4	.62	2.48		60	25.856	103.424	64.123
24PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC HDW.	LOT	2.00	2.00		100	-	-	-
SH'T. METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
THUMBWHEEL	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60	-	-	-
PANEL PC BOARD	1	2.00	2.00	818				
TOTALS			84.68	1349	1653		351.959	6137.175 (78.47)

SYSTEM ____________

SUB-ASSEMBLY ASSY & Test

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Cavity	1				100			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				200			
Covers	Lot				25			
Alignment	-				500			
Burn-In	-				500			
Test					2500			
TOTALS					4200			

APPENDIX A-19

DABS WITH COMM A, B, C, AND D

(LSI Version)

SYSTEM DABS Transponder　　　　SHEET 1 OF 9

SUB-ASSEMBLY IF Amplifier

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7416	1	.88	.88		8	.786	.786	.692
74121	1	.31	.31		8	.786	.786	.244
IN277	1	.36	.36		5	.715	.715	.257
IN4151	3	.30	.90		15	.150	.450	.135
IN4743	1	.20	.20		5	.786	.786	.157
2N5086	3	.17	.17		18	2.124	6.372	.361
MPS6515	1	.43	.43		6	.316	.316	.136
MPSH10	1	.33	.33		6	.316	.316	.104
SPS6797	8	.78	6.24		48	.715	5.720	4.462
5082-2835	1	.38	.38		5	.715	.75	2.72
TSTR. SI	1	.41	.41		6	.316	.316	.130
DIODE, SI	1	.32	.32		5	.155	.155	.050
CAP. STD.	4	.93	3.72		18	.629	2.516	2.340
CAP. CER.	2	.36	.72		10	.160	.320	.115
CAP. DISC.	45	.13	5.85		225	.291	13.095	1.702
CAP. T	3	.41	1.23		15	.550	1.650	.676
RESISTOR A/C	64	.03	1.92		320	.013	.832	.025
CHOKE	6	.36	2.16		36	2.120	12.720	4.579
COIL	5	.12	.60		30	.069	.345	.041
COIL RF	2	.28	.56		12	.475	.950	.266
CRYSTAL	1	8.00	8.00		15	1.500	1.500	12.000
FILTER	1	.28	.28		6	5.127	5.127	1.436
TOTALS								

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SYSTEM DABS Transponder

SUB-ASSEMBLY IF Amplifier (Cont'd)

SHEET 2 OF 9

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
TRANSF	6	.38	2.28		40	2.309	13.854	5.265
PC Board	1	4.00	4.00	818	25	-	-	-
MISC. Hdw.	LOT	.50	.50		50	-	-	-
SHT. MTC.	LOT	1.50	1.50	167	50	-	-	-
TOTALS			44.25	985	987 x 1.5 (1481)		70.342	35.445 (2.27)

SYSTEM DABS Transponder SHEET 3 OF 9

SUB-ASSEMBLY DPSK DEMOD./PPM MOD.

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7404	1	.26	.26		8	.715	.715	.186
7408	1	.26	.26		8	.120	.120	.031
7478	1	.31	.31		8	.715	.715	.222
74121	1	.31	.31		8	.715	.715	.222
74132	1	.64	.64		8	.120	.120	.077
67121	1	1.24	1.24		6	.715	.715	.887
2N3646	1	.68	.68		6	.316	.316	.215
MPSA56	2	.17	.34		12	.316	.632	.107
CAP DISC.	15	.13	1.95		75	.291	4.365	.567
CAP VAR.	1	.23	.23		15	8.599	8.599	1.978
RESISTOR FC	7	.03	.21		35	.013	.091	.003
PHASE LOCK LOOP	1	5.00	5.00		50	.715	.715	3.575
POTENTIOMETER	1	.42	.42		15	.664	.664	.279
PC Board	1	2.00	2.00	818	25	-	-	-
MISC. HDW	LOT	.50	.50		50	-	-	-
TOTALS			14.35	818	329 x 1.5 (494)		18.482	8.349 (2.03)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER SUPPLY - Comm A/B, C/D

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
MJE200	2	.57	1.14		16	1.970	3.940	2.246
MJE1100	1	1.33	1.33		8	1.970	1.970	2.620
MJE2801	1	1.33	1.33		8	1.970	1.970	2.620
IN4733A	1	.20	.20		5	.786	.786	.157
IN4735A	1	.20	.20		5	.786	.786	.157
IN4742A	1	.20	.20		5	.786	.786	.157
IN5229B	1	.15	.15		5	.786	.786	.118
2N2222A	1	.40	.40		6	.316	.316	.126
TRSTR, SI	1	.15	.15		6	.316	.316	.047
DIODE, SI	6	.35	2.10		30	.155	.930	.326
RESISTOR FC.	11	.03	.33		55	.013	.143	.004
RESISTOR MF	2	.37	.74		10	.042	.084	.047
COIL	4	.12	.48		24	.069	.276	.031
TYA - 1175.11	2	2.51	5.02		80	.629	1.258	3.158
CAP DC	10	.13	1.30		50	.291	2.910	.378
TRANSFORMER	1	3.55	3.55		40	8.998	8.998	31.943
POTENTIOMETER	2	.84	1.68		30	.644	1.328	1.116
PC BOARD	1	2.00	2.00	818	25	---	---	---
MISC. HDW.	LOT	.50	.50		50	---	---	---
SHT MTL.	LOT	.50	.50	167	50	---	---	---
TOTALS			23.30	985	479 x 115 (719)		27.364	45.251 (7.44)

SYSTEM DABS with Comm A&B and ELM UPLINK

SHEET 5 OF 9

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
7400	1	.24	.24		8	.120	.120	.029
7402	3	.24	.72		24	.120	.360	.086
7404	6	.26	1.56		48	.180	1.080	.281
7408	4	.26	1.14		32	.120	.480	.125
7432	1	.26	.26		8	.120	.120	.031
7478	2	.31	.62		16	.715	1.430	.443
74161	3	.54	1.62		24	.715	2.145	1.158
74166	6	.93	5.58		48	.715	4.290	3.990
74LS21	1	.24	.24		8	.060	.060	.014
NC 556	2	.85	1.70		10	.715	1.430	1.216
74126	1	.44	.44		8	.715	.715	.315
DM75S29	1	1.29	1.29		8	.715	.715	.922
MM74C910	1	7.40	7.40		8	.715	.715	5.290
74157	1	.72	.72		8	.715	.715	.515
8039	1	18.65	18.65		20	.507	.507	9.466
MCM4027AC4	1	3.80	3.80		16	.715	.715	2.717
TOTALS								

SYSTEM DABS with Comm A&B and ELM UPLINK

SUB-ASSEMBLY MAIN PC BOARD

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
LSI	4	10.00	40.00		80	.317	1.268	12.680
TSTR NPN	6	.14	.84		36	.316	1.896	.265
RESISTORS	119	.03	3.57		535	.013	1.547	.046
CAPACITORS	20	.13	2.60		100	.291	5.820	.757
CRYSTAL	2	10.00	20.00		30	1.500	3.000	30.000
P.C. BOARD	1	5.00	5.00	818	25	-	-	-
Misc. Hdw	Lot	1.50	1.50		50	-	-	-
LSI Socket	4	1.25	4.00		80	-	-	-
TOTALS			124.39	818	1230 x 2 2460		29.128	70.362 (10.87)

SYSTEM DABS TRANSPONDER

SUB-ASSEMBLY POWER AMPLIFIER

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
SD1522	1	13.10	13.10		50	17.010	17.010	222.831
SD1526	1	14.80	14.80		50	17.010	17.010	251.748
SD1530	1	22.50	22.50		50	35.215	35.215	792.338
SD1538	1	39.60	39.60		50	176.077	176.077	6972.649
CAPS-DISC	14	.13	1.82		70	.291	4.074	.530
COILS	8	.12	.96		40	.069	.552	.066
RESISTORS	5	.03	.15		25	.013	.065	.002
TVA-1319.9	1	2.85	2.85		40	.629	.629	1.793
TVA-1318.2	1	2.34	2.34		40	.629	.629	1.472
SUBSTRATE PC	1	15.00	15.00	818	50	-	-	-
RF CONN	1	1.35	1.35		25	-	-	-
ENCLOSURE	1	2.00	2.00	167	44	-	-	-
COVER	1	0.50	.50	42	22	-	-	-
MISC. HDW	LOT	0.50	.50		50	-	-	-
TOTALS			117.47	1027	606		251.261	8243.429 (147.64)

SYSTEM Baseline DABS Transponder

SHEET 8 OF 9

SUB-ASSEMBLY Chassis & Enclosure

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
FRONT PANEL	1			74	22	-	-	-
CHASSIS	1			184	44	-	-	-
TOP COVER	1	15.00	15.00	41	22	-	-	-
MOUNT	1			184	20	-	-	-
BOTTOM COVER	1			48	20	-	-	-
PANEL PC BOARD	1	5.00	5.00	818	100	-	-	-
PRESELECTOR	1	7.50	7.50		50	1.18	1.180	8.850
L.P. FILTER	1	3.00	3.00		25	11.844	11.844	35.532
POTENTIOMETER	1	.35	.35		15	.664	.664	.232
PUSH BT. SWITCH	1	.50	.50		25	18.596	18.596	9.298
ROTARY SWITCH	1	1.68	1.68		100	4.415	4.415	7.417
LAMP	7	.62	4.34		100	25.856	180.992	112.215
24 PIN CONNECTOR	2	.95	1.90		50	1.128	2.256	2.143
MISC. HDW.	LOT	2.00	2.00		100	-	-	-
SH'T METAL	LOT	3.00	3.00		200	-	-	-
RF CONNECTOR	1	1.23	1.23		15	-	-	-
FLEX CABLING	LOT	5.00	5.00		500	-	-	-
CODE SWITCH	4	1.00	4.00		100	2.395	9.580	9.580
PC CONNECTOR	4	1.26	5.04		60			
TOTALS			59.54	1349	1568		229.527	185.267 3.63

SYSTEM ____________

SUB-ASSEMBLY ASSY. & Test

SHEET 9 OF 9

ITEM NAME OR CATEGORY	QTY	UNIT COST	TOTAL COST	LABOR HOURS PER 1000 UNITS		UNIT FAILURE RATE	TOTAL FAILURE RATE	QTY x FAIL. RATE x UNIT COST
				MANUFACTURING	ASSEMBLY			
IF Amp	1				50			
Mod/Demod	1				50			
Pwr Supply	1				150			
Processor Board	1				25			
Power Amp	2				125			
Preselector	1				50			
LP Filter	1				50			
Front Panel	1				25			
Covers	Lot				25			
Alignment	"				600			
Burn-In	-				500			
Test	-				2050			
TOTALS					3700			

APPENDIX B

MATHEMATICAL FORMULATION OF THE COST MODEL

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APPENDIX B

1.0 GENERAL DESCRIPTION

ARINC Research Corporation's Life Cycle Cost Model (LCCM) has been adapted to evaluate the economic impact of proposed Discrete Address Beacon Systems (DABS) and to provide a basis for cost comparisons among the several DABS concepts under development. Twenty different concepts are being evaluated within the current ARINC Research study. The model evaluates each of these concepts in the Low Performance General Aviation user community.

The model itself is an expected value model which has been programmed in FORTRAN IV + for evaluations using a Digital Equipment Corporation PDP-11/34 minicomputer. The model computes the expected acquisition, installation, and logistic support costs by year and cumulatively for each concept. The program is designed for flexibility so that data changes can be readily implemented, sensitivity analyses performed, or additional data outputs obtained.

2.0 PROGRAM FEATURES

The DABS LCCM implementation consists of a common main program, called LCCOST, and seven subroutines, each designed to perform a specific function within the model. The seven routines and their functions are:

(1) COSACQ - Calculates the cost of acquisition of the DABS transponders by year and cumulative.

(2) COSINS - Calculates the cost of installation of the transponders by year and cumulative.

(3) COSLOG - Calculates the nonrecurring (investment) and recurring (operation and maintenance) costs of the DABS systems throughout their life cycle.

(4) TOTCUM - Determines the total equipment costs incurred each year and cumulative.

(5) PERGAC - Determines the annual cost per GA aircraft owner, as well as the annual cost per GA aircraft for the avionics equipment.

(6) DISCNT - Discounts constant dollars figures according to the guidelines set forth by the FAA.

(7) OUTTAB - Prints in table form the results of all the above computations.

Twenty-one input data files were used in exercising the DABS LCCM; one for each of the twenty configurations to be evaluated, and one user file called GENERAL tailored to the GA community. The system and user file names are specified at the beginning of the program's exercise from the teletype terminal keyboard, as are the number of years in the life cycle and the discount rate. The program then calls the designated files and reads them to obtain the specific data parameters used in the evaluation.

The specific outputs of the model, as dictated by the OUTTAB module, are:

(1) The total acquisition cost for the GA user category and designated system by year and cumulative.

(2) The total installation cost for the GA user category and system by year and cumulative.

(3) The total nonrecurring logistic support cost for the GA user category and system by year.

(4) The total recurring logistic support cost for the GA user category and system by year.

(5) The total logistic support cost for the GA user category and system by year and cumulative.

(6) The total cost for the GA user category and system by year and cumulative.

(7) The detailed cost element breakdowns of the nonrecurring, recurring and total logistic support costs for the GA user category and system by year.

(8) The cost per year to the GA aircraft owner and the cost per GA aircraft per year.

3.0 MODEL FORMULATION

The following describes the mathematical formulation of the DABS LCCM which has been implemented into the program LCCOST. The model computes on a yearly and cumulative basis the acquisition, installation, logistic support costs, and their totals for a given DABS system concept in the time period 1987-2002. The parameter definitions used in the model are presented after each set of formulas as well as in Appendix C.

3.1 Acquisition Costs

The acquisition costs are determined by the number of DABS systems purchased by the general aviation community each year and the average unit cost of the systems during the year (reflecting learning curves and amortization costs, if applied). The acquisition costs for year i are given by:

$$
\begin{aligned}
ACOS_i &= (NAV)\ (CRFT_i)(FUCOS_i) + AMCOS; \quad i \leq 2 \\
&= (NAV)\ (CRFT_i)\ (FUCOS_i) \qquad ; \quad i > 2
\end{aligned}
$$

where:

$$CRFT_i = NAC_i + NRAC_i$$

The cumulative acquisition cost is simply:

$$TCOSA_i = \sum_{j=1}^{i} ACOS_i$$

Variables are:

NAV = average no. of avionics systems per aircraft

$FUCOS_i$ = average system cost in year i

AMCOS = amortization cost

NAC_i = no. of new aircraft in year i

$NRAC_i$ = no. of aircraft retrofitted in year i

3.2 Installation Costs

The installation cost in the i'th year is determined by the number of DABS units installed in new aircraft or retrofitted into existing aircraft that year multiplied by the appropriate per unit installation rate. The resultant installation cost equation is given by:

$$ICOS_i = (NAV)[(NRAC_i)(RICOS) + (NAC_i)(INCOS)]$$

The cumulative installation cost is given by:

$$TCOSI_i = \sum_{j=1}^{i} ICOS_i$$

Variables are:

NAV = average no. of avionics systems per aircraft

$NRAC_i$ = no. of aircraft to be retrofitted in year i

RICOS = retrofit installation cost per system

NAC_i = no. of new aircraft in year i

INCOS = new aircraft installation cost per system

3.3 Logistic Support Costs

The logistic support cost is considered to be composed of the sum of eight cost elements, each having a nonrecurring (investment) and recurring (operating and maintenance) cost component. Hence, the logistic support cost in the i'th year is given by:

$$LCOS_i = \sum_{j=1}^{8} [NRCOS_{i,j} + RLCOS_{i,j}],$$

with $NRCOS_{i,j}$ representing the nonrecurring costs and $RLCOS_{i,j}$ representing the recurring costs. Similarly, the cumulative nonrecurring, recurring, and logistic support costs for year i are given by:

$$TCOSN_i = \sum_{j=1}^{i} TNRCOS_j$$

$$TCOSR_i = \sum_{j=1}^{i} TRLCOS_j$$

$$TCOSL_i = \sum_{j=1}^{i} LCOS_j$$

where:

$$TNRCOS_j = \sum_{k=1}^{8} NRCOS_{j,k}$$

$$TRLCOS_j = \sum_{k=1}^{8} RLCOS_{j,k}$$

The following paragraphs present the methodology for determining the individual cost elements and their components.

3.3.1 Initial and Replacement Spares

This cost element consists of the expenses associated with the procurement of the spares inventory. The nonrecurring component is the expenditure in the i'th year to purchase the spares required to satisfy the expected demand with a given level of spares sufficiency. In determining the nonrecurring costs, assumptions which should be noted are:

(1) A minimum of one spare of each type of the principal modules, or LRUs, and sub-modules, or SRUs, is assumed for each base.

(2) A minimum of one spare of each type LRU and SRU is assumed for each depot.

The recurring spares cost represents the cost of purchasing additional spares to replace those lost to the logistic system through condemnation and attrition.

The resultant components are given by:

$$NRCOS_{i,1} = \sum_{j=1}^{NLRU} \left[(NLSPRS_{i,j})(LUCOS_j) + \sum_{k=1}^{NSRU_j} (NSSPRS_{i,j,k})(SUCOS_{j,k}) \right]$$

where, for nonrepairable LRUs:

$$NLSPRS_{i,j} = INT[(NOB_i)(YDUM+SUF(2)\sqrt{YDUM})] +$$

$$INT[(NOD_i)(ZDUM+SUF(2)\sqrt{ZDUM})] + INT(TDUM)$$

$$+ INT(SDUM) + INT(RDUM) - NSPRL_j$$

$$YDUM = (TFAV_i)(FBLRU)(BSOBL)/((NOB_i)(LMTBF_j))$$

$$ZDUM = (TFAV_i)(FBLRU)(BSODL)/((NOD_i)(LMTBF_j))$$

$$TDUM = (TFAV_i)(FBLRU)(OSBL)/LMTBF_j$$

$$SDUM = (TFAV_i)(FBLRU)(OSDL)/LMTBF_j$$

$$RDUM = (TFAVI_i)(ROP)/LMTBF_j$$

and:

$$FBLRU = BIT + (1-BIT)(RTSS)$$

$$TFAV_i = (12)\ (AFHR)(NS_i)$$

$$NS_i = \sum_{j=1}^{i} (NAV)(CRFT_j)$$

where, for repairable LRUs:

$$NLRSPRS_{i,j} = \{\{Max[INT[(NOB_i)(YDUM + SUF(2)\sqrt{YDUM})], (MINB)(NOB_i)/LCOML_j]\}$$

$$+\{Max[INT[(NOD_i)(ZDUM + SUF(2)\sqrt{ZDUM})], (MINB)(NOD_i)/LCOML_j]\}\}$$

$$- NSPRL_j$$

and:

$$YDUM = (TFAV_i)(FBLRU)(RTS_j)(BMT)/[(NOB_j)(LMTBF_j)]$$

$$ZDUM = (TFAV_i)(FBLRU)(1-RTS_j)(DMT)/[(NOD_i)(LMTBF_j)]$$

where, for nonrepairable SRUs:

$$NSSPRS_{i,j,k} = INT[(NOB_i)(XDUM + SUF(3)\sqrt{XDUM})]$$

$$+ INT[(NOD_i)(XDUM+SUF(3)\sqrt{YDUM})]$$

$$+ INT(WDUM)+INT(TDUM)+INT(SDUM)-NSPRB_{j,k}$$

and:

$$XDUM = (TFAV_i)(FBLRU)(RTS_j)(BSOB)/[(NOB_i)(SMTBF_{j,k})]$$

$$YDUM = (TFAV_i)(FBLRU)(1-RTS_j)(BSOD)/[(NOD_i)(SMTBF_{j,k})]$$

$$WDUM = (TFAV_i)(FBLRU)(RTS_j)(OSB)/SMTBF_{j,k}$$

$$TDUM = (TFAV_i)(FBLRU)(1-RTS_j)(OSD)/SMTBF_{j,k}$$

$$SDUM = (TFAV_i)(ROP)/SMTBF_{j,k}$$

where, for repairable SRUs:

$$NSSPRS_{i,j,k} = \{\{Max[INT[(NOB_i)(XDUM + SUF(3)\sqrt{XDUM})],$$

$$(XMINB)(NOB_i)/LCOMS_{j,k}]\}$$

$$+\{Max[INT[(NOD_i)(YDUM+SUF(3)\sqrt{YDUM})],$$

$$(XMINB)(NOD_i)/LCOMS_{j,k}]\}\}-NSPRB_{j,k}$$

$$RLCOS_{i,1} = \sum_{j=1}^{NLRU} [(RLSPRS_{i,j})(LUCOS_j) + \sum_{k=1}^{NSRU_j} (RSSPRS_{j,k})(SUCOS_{j,k})]$$

where:

$$RLSPRS_{i,j} = INT[(TFAV_i)(COND_j)(1-ITWL_j)/LMTBF_j]$$

$$RSSPRS_{i,j,k} = INT[(TFAV_i)(CONDB_{j,k})(1-ITWS_{j,k})/SMTBF_{j,k}](1-ITWL_j)$$

Variables are:

NOB_i = no. of bases in year i

NOD_i = no. of depots in year i

SUF(2) = LRU spares suffuciency factor

$NSPRL_j$ = no. LRU_j spares purchased prior to year i

BSOBL = base LRU stocking objective

BSODL = depot LRU stocking objective

OSBL = average LRU order/ship time, base

OSDL = average LRU order/ship time, depot

ROP = requirements objectives period

BIT = fraction of failures isolated to LRU by Built-In Test Equipment

RTSS = fraction of failures isolated to LRU level at base without using BITE

AFHR = average monthly flight operating hours

NS_i = no. of systems in operation in year i

NAV = average no. of avionics units per aircraft

$CRFT_i$ = no. of aircraft receiving avionics in year i

NLRU = no. of LRUs in system

$LUCOS_j$ = unit cost of jth LRU

$NSRU_j$ = no. of SRUs in j'th LRU

$SUCOS_{j,k}$ = unit cost of k'th SRU in j'th LRU

MINB = minimum no. of each type LRU spare

$LCOML_j$ = no. of avionics unit types to which LRU_j is common

RTS_j = fraction of LRU_j failures isolated to SRU at base

BMT = base turnaround time

$LMTBF_j$ = mean time between failures of j'th LRU

DMT = depot turnaround time

SUF(3) = SRU spares sufficiency factor

$NSPRB_{j,k}$ = no. of $SRU_{j,k}$ spares purchased prior to year i

BSOB = base SRU stocking objective

$SMTBF_{j,k}$ = mean time between failures of $SRU_{j,k}$

BSOD = depot SRU stocking objective

OSB = average SRU order/shiptime, base

OSD = average SRU order shiptime, depot

XMINB = minimum no. of each type SRU spare

$LCOMS_{j,k}$ = no. of LRUs to which $SRU_{j,k}$ is common

$COND_j$ = fraction of LRU_j failures that are condemned

$CONDB_{j,k}$ = fraction of $SRU_{j,k}$ failures that are condemned

$ITWL_j$ = repair/throw-away flag for LRU_j

$ITWS_{j,k}$ = repair/throw-away flag for $SRU_{j,k}$

3.3.2 On-Aircraft Maintenance

This cost element represents the expected expenditures in performing on-aircraft corrective maintenance. This element contains only a recurring cost component, i.e., $NRCOS_{i,2} = 0$, and represents the costs associated with remove and replace actions, as well as preventive maintenance actions. The cost is determined as follows:

$$RLCOS_{i,2} = \sum_{j=1}^{NLRU} [(TFAV_i)(RMHB_j)/LMTBF_j]+(NS_i)(FPM)(PMMH)\}(BLR)$$

where:

$$TFAV_i = (12)(AFHR)(NS_i)$$

Variables are:

NLRU = no. of LRUs in avionics system

$RMHB_j$ = average time to remove and replace j'th LRU

$LMTBF_j$ = mean time between failures of j'th LRU

NS_i = no. of systems in operation in year i

FPM = frequency of preventive maintenance

PMMH = average time required to complete preventive maintenance actions

AFHR = average monthly flight operating hours

3.3.3 Off-Aircraft Maintenance

The expected material, labor, shipping, and documentation costs associated with performing corrective maintenance at the base and depot locations are represented by this cost element. Like the on-aircraft maintenance cost element, off-aircraft maintenance consists of a recurring cost component only, i.e., $NRCOS_{i,3} = 0$. This component is determined by:

$$RLCOS_{i,3} = TMAT_i + TLABOR_i + TSHIP_i + BDMTD_i + DDMTD_i$$

where:

$$TMAT_i = (TFAV_i)\Big[\sum_{j=1}^{NLRU} \Big[((FBLRU)(RTS_j)(RTLB_j)(BMC_j) + ((FBLRU)(RTS_j)(1-RTLB_j) + (FBLRU)(1-RTS_j))(DMC_j))/LMTBF_j + \sum_{k=1}^{NSRU_j} \Big[(FBLRU)(RTSB_{j,k})(BMCS_{j,k})(RTS_j) + (FBLRU)\big[(RTS_j)(1-RTSB_{j,k}) + (1-RTS_j)\big](DMCS_{j,k})\Big]/SMTBF_{j,k}\Big]\Big]$$

$$TLABOR_i = (TFAV_i)\Big[\sum_{j=1}^{NLRU} \Big[((FBLRU)(RTS_j)(RTLB_j)(LMTTR_j)(1-ITWL_j)(BLR)/LMTBF_j) + \sum_{k=1}^{NSRU_j}\Big[(FBLRU)(RTS_j)(RTSB_{j,k})(SMTTR_{j,k})(BLR)) + ((FBLRU)\big[(RTS_j)(1-RTSB_{j,k}) + (1-RTS_j)\big](SMTTR_{j,k})(DLR))(1-ITWS_{j,k})/SMTBF_{j,k}\Big]\Big]\Big]$$

$$TSHIP_i = (PACK)(TFAV_i)\big[XLTTR_i + XSTTR_j\big)\big[(2)(YMIL)(SSHC) + (XMIL)(SHC)\big] + (XLSHP_i)\big]$$

and:

$$XLTTR_i = \sum_{j=1}^{NLRU} (WT_j)(COND_j)/LMTBF_j$$

$$XSTTR_i = \sum_{j=1}^{NLRU} \sum_{k=1}^{NSRU_j} (WTB_{j,k})(CONDB_{j,k})/SMTBF_{j,k}$$

$$XLSHP_i = \sum_{j=1}^{NLRU} [(WT_j)[(FBLRU)[(1-RTS_j)+(RTS_j)(1-RTLB_j)]$$

$$(2)(YMIL)(SSHC)(1-ITWL_j)+[(FBLRU)(1-RTS_j)$$

$$((YMIL)(SSHC)+(XMIL)(SHC))(ITWL_j)]]/LMTBF_j]$$

$$XSSHP_i = \sum_{j=1}^{NLRU} \sum_{k=1}^{NSRU_j} [(WTB_{j,k})[(FBLRU)(RTS_j)(1-RTSB_{j,k})(2)$$

$$(YMIL)(SSHC)(1-ITWS_{j,k})+(FBLRU)(RTS_j)((YMIL)(SSHC)+$$

$$(XMIL)(SHC))(ITWS_{j,k})]/SMTBF_{j,k}]$$

$$TFAV_i = (12)(AFHR)(NS_i)$$

$$FBLRU = BIT+(1-BIT)(RTSS)$$

where:

$$BDMTD_i = (BDOC + (LRUT + SRUT)(TFR))(TFAV_i)(BLR)$$

$$DDMTD_i = (DDOC + (LRUT + SRUT)(TFR))(TFAV_i)(DLR)$$

and:

$$BDOC = (ONAC + OFAC + STR)/UMTBF$$

$$DDOC = (OFAC + STR)/UMTBF$$

$$LRUT = \sum_{j=1}^{NLRU} (FBLRU)(1-RTS_j)/LMTBF_j$$

$$SRUT = \sum_{j=1}^{NLRU} \sum_{k=1}^{NSRU_j} (FBLRU)(RTS_j)(1-RTSB_{j,k})/SMTBF_{j,k}$$

Variables are:

$NLRU$ = no. of LRUs in avionics system

RTS_j = fraction of LRU_j failures isolated to SRU at base

$RTLB_j$ = fraction of repairable LRU_j failures repaired at base

BMC_j = average base materials cost per maintenance action on j'th LRU

DMC_j = average depot materials cost per maintenance action on j'th LRU

$LMTBF_j$ = mean time between failures of j'th LRU

$NSRU_j$ = no. of SRUs in j'th LRU

$RTSB_{j,k}$ = fraction of repairable $SRU_{j,k}$ repaired at base

$BMCS_{j,k}$ = average base materials cost per maintenance action on $SRU_{j,k}$

$DMCS_{j,k}$ = average depot materials cost per maintenance action on $SRU_{j,k}$

$SMTBF_{j,k}$ = mean time between failures of $SRU_{j,k}$

$LMTTR_j$ = mean time to repair j'th LRU

$ITWL_j$ = repair/throw-away flag for j'th LRU

BLR = base labor rate

$SMTTR_{j,k}$ = mean time to repair $SRU_{j,k}$

DLR = depot labor rate

$ITWS_{j,k}$ = repair/throw-away flag for $SRU_{j,k}$

$PACK$ = packaging factor = packed wt./unpacked wt.

$YMIL$ = average no. of shipping zones between base and depot

$SSHC$ = shipping rate per lb between base and depot

$XMIL$ = average no. of shipping zones to first destination

SHC = shipping rate per lb to first destination

WT_j = weight of j'th LRU

$COND_j$ = fraction of failed LRU_j that are condemned

$WTB_{j,k}$ = weight of $SRU_{j,k}$

$CONDB_{j,k}$ = fraction of failed $SRU_{j,k}$ that are condemned

AFHR = average monthly flight operating hours

NS_i = no. of systems in operation in year i

BIT = fraction of failures isolated to LRU by Built-In Test Equipment

RTSS = fraction of failures isolated to LRU at base without using BITE

ONAC = time required to complete on-aircraft maintenance records

OFAC = time required to complete off-aircraft maintenance records

STR = time required to complete supply transaction records

TFR = time required to complete transportation forms

UMTBF = mean time between system failures

3.3.4 Inventory Entry and Supply Management

This cost element represents the cost associated with introducing and maintaining new coded supply items in the user inventory and the management cost of maintaining a supply inventory for all of the coded items that are stocked at the repair sites. The first year's inventory entry cost is treated as a nonrecurring cost ($NRCOS_{i,4}$); the supply management cost is treated as a recurring cost throughout ($RLCOS_{i,4}$). The resultant components are given by:

$$\begin{aligned} NRCOS_{i,4} &= (IAMC)(NIC)(TIC)(NICB); \quad i = 1 \\ &= 0 \qquad\qquad\qquad\qquad\quad ; \quad i \neq 1 \end{aligned}$$

where:

$$\begin{aligned} NICB &= 1; \ FRAV \neq 0. \\ &= 0; \ FRAV = 0. \end{aligned}$$

and:

$$\begin{aligned} RLCOS_{i,4} &= [(NOB_i)(NOIB)(HOLDB)+(NOD_i)(NOID)(HOLDD)](NICB); \quad i = 1 \\ &= [(IAMC)(NIC)(TIC)+(NOB_i)(NOIB)(HOLDB)+(NOD_i)(NOID)(HOLDD)] \\ &\quad (NICB); \quad i \neq 1 \end{aligned}$$

Variables are:

IAMC = cost of introducing each new coded item

NIC = faction of inventory coded items that are new

TIC = total no. of inventory coded items

NOB_i = no. of bases in year i

NOIB = no. of different item types stocked at base

HOLDB = average annual holding cost per item type, base

NOD_i = no. of depots in year i

NOID = no. of different item types stocked at depot

HOLDD = average annual holding cost per item type, depot

3.3.5 Special Support Equipment

Included in this cost element are the nonrecurring costs of purchasing special test equipment ($NRCOS_{i,5}$) and the recurring costs of operating that equipment ($RLCOS_{i,5}$). It is assumed in the model that the test equipment is unique to the systems being evaluated. It is further assumed that there will be a minimum of one of each type of support equipment at each base and depot facility. The nonrecurring and recurring costs of special support equipment in the i'th year, assuming that $NSEB_m$ and $NSED_m$ units of the m'th equipment type have been purchased prior to year i at the base and depot level, are given by:

$$NRCOS_{i,5} = NNSEB_i + NNSED_i$$

where:

$$NNSEB_i = \sum_{m=1}^{JSEB} [Max\{INT[(PFAV_i)(BMH(1))(UTILB_m)/((UMTBF)$$

$$(AVALB_m)(BETA))],(MINSEB)(NOB_i)/LCOMB_m\} - NSEB_m]$$

$$(USECOB_m)$$

$$NNSED_i = \sum_{m=1}^{JSED} [Max\{INT[(PFAV_i)(DMH(1))(UTILD_m)/(UMTBF)$$

$$(AVALD_m)(DETA))],(MINSED)(NOD_i)/LCOMD_m\}$$

$$- NSED_m](USECOD_m)$$

$$PFAV_i = (12)(PFHR)(NS_i)$$

and:

$$RLCOS_{i,5} = RNSEB_i + RNSED_i$$

where:

$$RNSEB_i = \sum_{m=1}^{JSEB} [Max\{(PFAV_i)(BMH(1))(UTILB_m)(SECOB)/((UMTBF)$$

$$(AVALB_m)(BETA)),(MSEBO)(NSEB_m)\}]$$

$$RNSED_i = \sum_{m=1}^{JSED} [Max\{(PFAV_i)(DMH(1))(UTILD_m)(SECOD)/UMTBF)$$

$$(AVALD_m)(DETA)),(MSEDO)(NSED_m)\}]$$

Variables are:

PFHR = peak monthly flight operating hours

BMH(1) = average labor hours to isolate failure in principal electronics to SRU level

$UTILB_m$ = utilization rate of m'th type support equipment

UMTBF = mean time between system failures

BETA = base support equipment hours available per month

$AVALB_m$ = availability of m'th type support equipment, base

MINSEB = minimum no. of each type support equipment, base

$LCOMB_m$ = no. avionics unit types to which m'th type base support equipment is common

$USECOB_m$ = unit cost of m'th type base support equipment

JSEB = no. of different types base support equipment

NOB_i = no. of bases in year i

JSED = no. of different types depot support equipment

NOD_i = no. of depots in year i

$UTILD_m$ = utilization rate of m'th type depot support equipment

DETA = depot support equipment hours available per month

$AVALD_m$ = availability m'th type depot support equipment

MINSED = minimum no. of each type depot support equipment

$LCOMD_m$ = no. of avionics unit types to which m'th type depot support equipment is common

$USECOD_m$ = unit cost of m'th type depot support equipment

NS_i = no. of systems in operation in year i

SECOB = support equipment operating cost, base

MSEBO = minimum annual support equipment operating cost, base

SECOD = support equipment operating cost, depot

MSEDO = minimum annual support equipment operating cost, depot

3.3.6 Training

The training cost consists of the specialized maintenance training required to meet the expected corrective maintenance demands ($NRCOS_{i,6}$) and the recurrent cost of additional specialized training resulting from the turnover of repair personnel ($RLCOS_{i,6}$). It is assumed that a minimum of one person per maintenance

site will receive training. The training costs incurred in year i, then, assuming that NPERB base personnel and NPERD depot personnel have been trained prior to year i are:

$$NRCOS_{i,6} = (NBPER_i)(TCOSB)+(NDPER_i)(TCOSD)$$

where:

$$NBPER_i = Max\{INT[(TFAV_i)(AMHB)/((PMB)(PRODB)(UMTBF))], (MINBP)(NOB_i)\} - NPERB$$

$$NDPER_i = Max\{INT[(TFAV_i)(AMHD)/((PMD)(PRODD)(UMTBF))], (MINDP)(NOD_i)\} - NPERD$$

$$TFAV_i = (12)(AFHR)(NS_i)$$

$$AMHB = (UMTBF)\{[(1-BIT)(BMHS)/UMTBF]+(FBLRU)\sum_{j=1}^{NLRU}[[(BMH_j)(RTS_j) + (RTLB_j)(LMTTR_j)]/LMTBF_j+(RTS_j)\sum_{k=1}^{NSRU}[(RTSB_{j,k})(SMTTR_{j,k})/SMTBF_{j,k}]]\}$$

$$AMHD = (UMTBF)\{[(1-BIT)(1-RTSS)(DMHS)/UMTBF] + \sum_{j=1}^{NLRU}[[[(1-BIT)(1-RTSS)+(FBLRU)(1-RTS_j)](DMH_j)+ (FBLRU)[(1-RTLB_j)(LMTTR_j)]]/LMTBF_j + \sum_{k=1}^{NSRU_j}[[(1-BIT)(1-RTSS) +(FBLRU)[(1-RTS_j)+(RTS_j)(1-RTSB_{j,k})]](SMTTR_{j,k})/(SMTBF_{j,k})]]\}$$

and:

$$RLCOS_{i,6} = (NPERB)(TCOSB)(TRB)+(NPERD)(TCOSD)(TRD)$$

Variables are:

$TCOSB$ = training cost per base repair person

$TCOSD$ = training cost per depot repair person

$AMHB$ = average labor-hours per maintenance action, base

$UMTBF$ = mean time between system failures

BIT = fraction of failures isolated to LRU by Built-In Test Equipment

$BMHS$ = average labor-hours to isolate failure to LRU at base

$NLRU$ = no. of LRUs in avionics system

BMH_j = average labor-hours to isolate failures in j'th LRU to SRU level at base

RTS_j = fraction LRU_j failures isolated to SRU at base

$RTLB_j$ = fraction of repairable LRU_j repaired at base

$LMTTR_j$ = mean time to repair LRU_j

$LMTBF_j$ = mean time between failures j'th LRU

$NSRU_j$ = no. of SRUs in j'th LRU

$RTSB_{j,k}$ = fraction of repairable $SRU_{j,k}$ repaired at base

$SMTTR_{j,k}$ = mean time to repair $SRU_{j,k}$

$SMTBF_{j,k}$ = mean time between failures of $SRU_{j,k}$

PMB = available hours per year per repair person, base

$PRODB$ = productivity of base repair personnel

$MINBP$ = minimum no. repair personnel per base

NOB_i = no. of bases in year i

$AMHD$ = average labor-hours per maintenance action, depot

$RTSS$ = fraction of failures isolated to LRU at base

$DMHS$ = average labor-hours to isolate failure to LRU at depot

DMH_j = average labor-hours to isolate failures in j'th LRU to SRU level at depot

PMD = available hours per year per repair person depot

PRODD = productivity of depot repair personnel

MINDP = minimum no. repair personnel per depot

NOD_i = no. of depots in year i

AFHR = average monthly flight operating hours

NS_i = no. of systems in operation in year i

TRB = turnover rate, base repair personnel

TRD = turnover rate, depot repair personnel

3.3.7 Data Management and Technical Documentation

The data management and technical documentation element consists only of the nonrecurring cost ($NRCOS_{i,7}$) associated with the preparation of base and depot level documentation ($RLCOS_{i,7} = 0$). These costs are given by the equation:

$$NRCOS_{i,7} = (CPP)\left[(NPDB)(NNBAS_i)+(NPDD)(NNDEP_i)\right]$$

where:

$$NNBAS_i = NOB_i \quad ; \; i = 1$$

$$= NOB_i - NOB_{(i-1)} ; \; i \neq 1$$

$$NNDEP_i = NOD_i \quad ; \; i = 1$$

$$= NOD_i - NOD_{(i-1)} ; \; i \neq 1$$

Variables are:

CPP = cost per page, original technical documentation

NPBD = no. of pages base level documentation

NPDD = no. of pages depot level documentation

NOB_i = no. of bases in year i

NOD_i = no. of depots in year i

3.3.8 Facilities

The facilities costs are considered to consist of the recurring operating costs of the repair facilities (e.g., space rent, electricity, general tools, etc.). It is assumed that no new support facilities will be required for the system; hence, $NRCOS_{i,8} = 0$. The recurring cost ($RLCOS_{i,8}$) is then given by:

$$RLCOS_{i,8} = (FOCB)(NOB_i) + (FOCD)(NOD_i)$$

Variables are:

FOCB = annual base facilities cost attributable to system being analyzed

FOCD = annual depot facilities cost attributable to system being analyzed

NOB_i = number of base maintenance sites, year i

NOD_i = number of depot maintenance sites, year i

APPENDIX C

LIFE-CYCLE-COST MODEL PROGRAM

```
C                             PROGRAM LCCOST
C
C        THE PROGRAM LCCOST DETERMINES THE TOTAL LIFE CYCLE COST OF
C        SPECIFIED AVIONICS UNIT(S). DATA IS INPUT TO THE PROGRAM
C        BY MEANS OF THE USER TERMINAL, A SYSTEM FILE (SFILE), AND
C        A USER FILE (UFILE). THE PROGRAM USES THE DATA TO DETERMINE
C        ANNUAL ACQUISITION COSTS, INSTALLATION COSTS, AND LOGISTIC
C        SUPPORT COSTS, WHICH ARE THEN OUTPUT IN TABULAR FORM IN
C        BOTH CONSTANT AND DISCOUNTED DOLLARS.
C
      PROGRAM LCCOST
C
C    *ESTABLISH COMMON BLOCKS
C
      COMMON/ACQUIZ/ACOS(25), TCOSA(25)
      COMMON/ARCRFT/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/CAT/CLCC, TNRCAT(9), TRLCAT(9), TPROG(25), CPROG(25)
      COMMON/INSTAL/ICOS(25), TCOSI(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
     1              TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
      COMMON/MISCLO/ NBAS(25), NDEP(25), UMTBF
      COMMON/SYSTEM/BMC(20),BMCS(20,20),COND(20),CONDB(20,20),DMC(20),
     1              DMCS(20,20),ITWL(20),ITWS(20,20),LCOML(20),
     2              LCOMS(20,20),LMTBF(20),NLRU,NSRU(20),RMHB(20),
     3              RTS(20),RTSB(20,20),SMTBF(20,20)
      COMMON/VIONIX/AMCOS, FRAV, FUCOS, INCOS, LUCOS(20), NAV,
     1              PQTY, RICOS, SUCOS(20,20), WT(20), WTB(20,20), XLRN,
     2              BMH(20), DMH(20), RTLB(20), LMTTR(20), SMTTR(20,20)
      COMMON/NAMES/SNAME, UNAME
C
C    *DECLARE VARIABLES AND DATA
C
      INTEGER BEGYR,ENDYR,ITWL,ITWS,LCOML,LCOMS,NBAS,NDEP,NLRU,NNB,NND
      INTEGER NOBAS,NODEP,NREYR,NSRU,NUM,NYRS,YEAR,YR,BASEYR
      REAL AMCOS,BMC,BMCS,COND,CONDB,DIST,DMC,DMCS,FRAV,FUCOS,ICOS
      REAL INCOS,LMTBF,LUCOS,NAC,NNAC(25),NRAC,PQTY,RICOS,RMHB
      REAL RTS,RTSB,SMTBF,SUCOS,TNRAC,UMTBF,WT,WTB,XDIS,XLRN,LMTTR,NRCOS
      REAL LDIST,SDIST,KFAC
      LOGICAL*1 ANS, SNAME(65), UNAME(35), SFILE(16), UFILE(16)
      DATA SFILE/'S','Y','0',':',6*'X','.','D','A','T',0,0/
      DATA UFILE/'S','Y','0',':',6*'Y','.','D','A','T',0,0/
      DATA UMTBF/0.0/, SNAME/65*0/, UNAME/35*0/
C
C    *INITIALIZE TERMINAL INPUT VARIABLES
C
10    WRITE(1,*) '-------AVIONICS LIFE CYCLE COST EVALUATION-------'
      WRITE(1,*) '  '
      WRITE(1,*) '  '
      WRITE(1,*) 'ENTER NUMBER OF SYSTEMS TO BE EVALUATED IN THIS RUN '
      READ(1,1001) NUM
      WRITE(1,*) '  '
```

```
20    WRITE(1,*) 'SYSTEM FILE NAME?'
      READ(1,1002) (SFILE(I), I = 5, 10)
      WRITE(1,*) ' '
30    WRITE(1,*) 'USER FILE NAME?'
      READ(1,1002) (UFILE(I), I = 5,10)
      WRITE(1,*) ' '
      WRITE(1,*) 'NUMBER OF YEARS IN LIFE CYCLE?'
      READ(1,1001) NYRS
      WRITE(1,*) ' '
      WRITE(1,*) 'DISCOUNT RATE?'
      READ(1,1003) XDIS
      WRITE(1,*) ' '
      WRITE(1,*) 'BASE YEAR FOR DISCOUNTING PURPOSES? (E.G. 1980)'
      READ(1,1013) BASEYR
      WRITE(1,*) ' '
      WRITE(1,*) 'VALUE OF K FACTOR (FOR MTBF SENSITIVITY ANALYSIS)?'
      WRITE(1,*) '(NOTE:ENTER 1.0 IF YOU DO NOT WISH TO PERFORM THE'
      WRITE(1,*) 'SENSITIVITY ANALYSIS.)'
      READ(1,1003) KFAC
      WRITE(1,*) ' '
C
C    *READ DATA FROM SYSTEM AND USER FILES
C
      OPEN(UNIT=2,NAME=SFILE,TYPE='OLD',READONLY,ERR=901)
      OPEN(UNIT=3,NAME=UFILE,TYPE='OLD',READONLY,ERR=902)
40    READ(2,1004) (SNAME(I), I = 1, 65)
      READ(3,1004) (UNAME(I), I = 1, 35)
C
C    *INITIALIZE YEAR, NNAC, NRAC, NBAS, AND NDEP ARRAYS BY READING
C    *APPROPRIATE DISK FILE
C
      DO 50 I = 1, NYRS
        READ(3,1006) YEAR(I),NNAC(I),NRAC(I),NBAS(I),NDEP(I)
50    CONTINUE
C
      DO 100 N = 1, NUM
        READ(2,1010) UCOS,AMCOS,PQTY
        READ(3,1005) INCOS,RICOS,DIST,LDIST,SDIST
        READ(3,1012) NAV,FRAV,XLRN
C
        DO 55 I = 1, NYRS
C
C         *DETERMINE NUMBER OF NEW AIRCRAFT IN AVIONICS FLEET IN YEAR I
C
          NAC(I) = AINT(FRAV*NNAC(I))
55      CONTINUE
C
C      *CALCULATE ACQUISITION AND INSTALLATION COSTS
C
        CALL COSACQ(NYRS,UCOS,DIST)
C
C      *CALCULATE THE COST OF EACH LRU AND SRU, TAKING INTO
C      *CONSIDERATION DEALER MARK-UP/-DOWN
```

```
C
      READ(2,1006) NLRU
      DO 70 I = 1, NLRU
        READ(2,1004)
        READ(2,1007) LUCOS(I),LMTBF(I),ITWL(I),LCOML(I)
        READ(2,1008) WT(I),RTS(I),COND(I),NSRU(I)
        READ(2,1005) RMHB(I),BMC(I),DMC(I)
        READ(2,1005) BMH(I),DMH(I),RTLB(I),LMTTR(I)
        LUCOS(I) = LUCOS(I)*(1 + LDIST)
        LMTBF(I) = LMTBF(I)/KFAC
        BMC(I) = BMC(I)*KFAC
        DMC(I) = DMC(I)*KFAC
        IF (NSRU(I) .EQ. 0) GO TO 60
        DO 60 J = 1, NSRU(I)
          READ(2,1004)
          READ(2,1007) SUCOS(I,J),SMTBF(I,J),ITWS(I,J),LCOMS(I,J)
          READ(2,1008) WTB(I,J),RTSB(I,J),CONDB(I,J)
          READ(2,1005) BMCS(I,J),DMCS(I,J),SMTTR(I,J)
          SUCOS(I,J) = SUCOS(I,J)*(1 + SDIST)
          SMTBF(I,J) = SMTBF(I,J)/KFAC
          BMCS(I,J) = BMCS(I,J)*KFAC
          DMCS(I,J) = DMCS(I,J)*KFAC
60      CONTINUE
70    CONTINUE
C
C    *CALCULATE MTBF FOR SYSTEM
C
      DO 90 I = 1, NLRU
        UMTBF = UMTBF + 1./LMTBF(I)
90    CONTINUE
      UMTBF = 1./UMTBF
C
C    *CALCULATE LOGISTIC SUPPORT COST OF AVIONICS SYSTEM
C
      CALL COSLOG(NYRS,OWNER)
C
C    *REPEAT CALCULATIONS FOR NEXT AVIONICS SYSTEM TO BE EVALUATED
C
100 CONTINUE
C
C  *CALCULATE TOTALS FOR LIFE CYCLE
C
    CALL TOTCUM(NYRS)
C
C  *PRINT ANNUAL COST PER OWNER AND PER AIRCRAFT
C
    DSCNT = 0.0
    CALL PERGAC(NYRS,DSCNT)
C
C  *PRINT ANNUAL LOGISTIC SUPPORT COSTS BY CATEGORY AND TOTAL LIFE
C  *CYCLE COSTS BY YEAR
C
    CALL OUTTAB(NYRS,DSCNT)
```

AD-A112 957 ARINC RESEARCH CORP ANNAPOLIS MD F/G 17/7
COST ANALYSIS OF THE DISCRETE ADDRESS BEACON SYSTEM FOR THE LOW--ETC(U)
SEP 81 S KOWALSKI, K PETER, A SCHUST, D SWANN DOT-FA76WA-3788
UNCLASSIFIED 1326-01-15-2529 DOT/FAA/RD-81/61 NL

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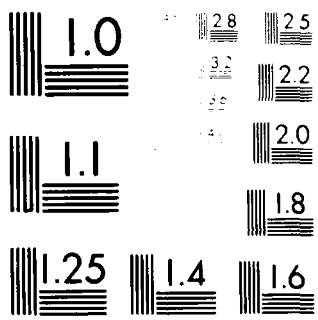


MICROCOPY RESOLUTION TEST CHART

```
C
C     *CALCULATE AND PRINT DISCOUNTED ANNUAL LOGISTIC SUPPORT COSTS
C     *BY CATEGORY AND DISCOUNTED TOTAL LIFE CYCLE COSTS BY YEAR
C
      CALL DISCNT(NYRS,XDIS,BASEYR)
      CALL TOTCUM(NYRS)
      CALL PERGAC(NYRS,XDIS)
      CALL OUTTAB(NYRS,XDIS)
C
C     *CLOSE INPUT FILES
C
      CLOSE(UNIT=2,ERR=903)
      CLOSE(UNIT=3,ERR=904)
C
      GO TO 999
C
C     *ERROR STATEMENTS
C
901   WRITE(1,*) 'ERROR IN OPENING SFILE. PLEASE TRY AGAIN.'
      GO TO 20
C
902   WRITE(1,*) 'ERROR IN OPENING UFILE. PLEASE TRY AGAIN.'
      CLOSE(UNIT=2,ERR=903)
      GO TO 30
C
903   WRITE(1,*) 'ERROR IN CLOSING SFILE. PROGRAM ABORTED.'
      GO TO 999
C
904   WRITE(1,*) 'ERROR IN CLOSING UFILE. PROGRAM ABORTED.'
C
C     *FORMAT STATEMENTS
C
1001  FORMAT(I2)
1002  FORMAT(10A1)
1003  FORMAT(F4.2)
1004  FORMAT(20X,65A1)
1005  FORMAT(10X,F8.2,3(7X,F8.2),7X,F4.2)
1006  FORMAT(10X,I8,7X,F8.0,7X,F8.0,7X,I8,7X,I2)
1007  FORMAT(10X,2(F8.2,7X),I8,7X,I8)
1008  FORMAT(10X,2(F8.2,7X),F8.3,7X,I8)
1009  FORMAT(10X,I8,7X,F8.2)
1010  FORMAT(10X,F8.2,7X,F8.1,2(7X,F8.2))
1011  FORMAT(10X,4(I8,7X))
1012  FORMAT(10X,I8,3(7X,F8.3))
1013  FORMAT(I4)
C
999   STOP
      END
```

```
C                         SUBROUTINE COSACQ
C
C        THE COSACQ MODULE DETERMINES THE ACQUISITION COST OF THE SPECI-
C        FIED AVIONICS EQUIPMENT FOR EACH YEAR IN THE LIFE CYCLE. ACOS
C        REPRESENTS THE ACQUISITION COSTS INCURRED IN YEAR I; TCOSA REP-
C        RESENTS THE TOTAL ACQUISITION COSTS INCURRED PRIOR TO YEAR I.
C
      SUBROUTINE COSACQ(NYRS,UCOS,DIST)
C
C     *ESTABLISH COMMON BLOCKS
C
      COMMON/ACQUIZ/ACOS(25), TCOSA(25)
      COMMON/ARCRFT/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/INSTAL/ICOS(25), TCOSI(25)
      COMMON/VIONIX/AMCOS, FRAV, FUCOS, INCOS, LUCOS(20), NAV,
     1              PQTY, RICOS, SUCOS(20,20), WT(20), WTB(20,20), XLRN,
     2              BMH(20), DMH(20), RTLB(20), LMTTR(20), SMTTR(20,20)
C
C     *DECLARE VARIABLES
C
      INTEGER NYRS, YEAR
      REAL ACOS,AMCOS,COST,CRFT,FRAV,FUCOS,ICOS,INCOS,LUCOS
      REAL NAC,NPUR,NRAC,RICOS,SUCOS,TCOSA,TCOSI,WT,WTB,LMTTR,LC
      LOGICAL*1 ANS
      DATA ACOS/25*0.0/, TCOSA/25*0.0/
C
C     *INITIAL PRODUCTION COSTS ARE AMORTIZED OVER THE FIRST
C     *TWO YEARS OF PRODUCTION
C
      AMCOS = AMCOS/(2.0*PQTY)
      TQTY = 0.0
      ANS = 'Y'
C
      DO 10 I = 1, NYRS
C
        FUCOS = UCOS
C
C      *COST IS GREATER IF AMORTIZING INITIAL PRODUCTION COSTS
C      *(START-UP COSTS ARE AMORTIZED OVER FIRST TWO YEARS OF
C      *PRODUCTION.)
C
        IF (I .LE. 2) FUCOS = UCOS + AMCOS
C
C      *IS THE LEARNING CURVE TO BE USED?
C
        IF (ANS .NE. 'Y') GO TO 5
        IF (I .NE. 1) GO TO 2
        WRITE(1,*) 'IS THE LEARNING CURVE FACTOR TO BE APPLIED?'
        READ(1,1001) ANS
        WRITE(1,*) ' '
        IF (ANS .NE. 'Y') GO TO 5
2       LC = (TQTY + PQTY/2.)**(ALOG(XLRN)/ALOG(2.0))
        TQTY = TQTY + PQTY
        FUCOS = FUCOS * LC
```

```
C
C       *ADJUST FUCOS TO REFLECT DEALER MARK-UP/-DOWN
C
         FUCOS = FUCOS*(1 + DIST)
C
C       *DETERMINE NUMBER OF A/C IN WHICH SYSTEM IS TO BE INSTALLED
C       *IN YEAR I
C       *IF (RETROFIT PERIOD IS OVER) NRAC(I) = 0
C
         CRFT(I) = NAC(I) + NRAC(I)
C
C       *CALCULATE NUMBER OF AVIONICS UNITS PURCHASED IN YEAR I
C
         NPUR = NAV*CRFT(I)
C
C       *CALCULATE COST ASSOCIATED WITH ACQUISITION OF AVIONICS UNITS IN
C       *YEAR I
C
         COST = NPUR*FUCOS
C
C       *UPDATE ACQUISITION COSTS FOR YEAR I
C
         ACOS(I) = ACOS(I) + COST
C
C       *CALCULATE INSTALLATION COST FOR FLEET
C
         CALL COSINS(NYRS,I)
C
10    CONTINUE
1001  FORMAT(2A1)
C
      RETURN
      END
```

```
C                          SUBROUTINE COSINS
C
C      THE COSINS MODULE DETERMINES THE INSTALLATION COST OF THE
C      SPECIFIED AVIONICS EQUIPMENT FOR EACH YEAR IN THE LIFE CYCLE.
C      ICOS REPRESENTS THE INSTALLATION COSTS INCURRED IN YEAR I;
C      TCOSI REPRESENTS THE TOTAL INSTALLATION COSTS INCURRED PRIOR
C      TO YEAR I.
C
       SUBROUTINE COSINS(NYRS,I)
C
C     *ESTABLISH COMMON BLOCKS
C
       COMMON/ARCRFT/CRFT(25), NAC(25), NRAC(25), YEAR(25)
       COMMON/INSTAL/ICOS(25), TCOSI(25)
       COMMON/VIONIX/AMCOS, FRAV, FUCOS, INCOS, LUCOS(20), NAV,
      1              PQTY, RICOS, SUCOS(20,20), WT(20), WTB(20,20), XLRN,
      2              BMH(20), DMH(20), RTLB(20), LMTTR(20), SMTTR(20,20)
C
C     *DECLARE VARIABLES
C
C
       INTEGER NYRS, YEAR
       REAL AMCOS,COST,CRFT,FRAV,FUCOS,ICOS,INCOS,LUCOS,NAC
       REAL NRAC,PQTY,RICOS,SUCOS,TCOSI,WT,WTB,XLRN,LMTTR
       DATA ICOS/25*0.0/, TCOSI/25*0.0/
C
C     *CALCULATE INSTALLATION COST FOR YEAR I
C
       COST = NAV*(NRAC(I)*RICOS + NAC(I)*INCOS)
C
C     *UPDATE INSTALLATION COSTS FOR YEAR I
C
       ICOS(I) = ICOS(I) + COST
       RETURN
       END
```

```
C                               SUBROUTINE COSLOG
C
C         THE MODULE COSLOG DETERMINES THE RECURRING AND NONRECURRING
C         LOGISTIC SUPPORT COSTS OF THE SPECIFIED AVIONICS EQUIPMENT
C         IN EACH OF EIGHT CATEGORIES: SPARES, ON-AIRCRAFT MAINTENANCE,
C         OFF-AIRCRAFT MAINTENANCE, INVENTORY ENTRY AND SUPPLY MANAGE-
C         MENT, SPECIAL SUPPORT EQUIPMENT, PERSONNEL TRAINING, DATA
C         MANAGEMENT AND TECHNICAL DOCUMENTATION, AND FACILITIES.
C
      SUBROUTINE COSLOG(NYRS)
C
C    *ESTABLISH COMMON BLOCKS
C
      COMMON/ARCRFT/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
     1              TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
      COMMON/MISCLO/NBAS(25), NDEP(25), UMTBF
      COMMON/SYSTEM/BMC(20),BMCS(20,20),COND(20),CONDB(20,20),DMC(20),
     1              DMCS(20,20),ITWL(20),ITWS(20,20),LCOML(20),
     2              LCOMS(20,20),LMTBF(20),NLRU,NSRU(20),RMHB(20),
     3              RTS(20),RTSB(20,20),SMTBF(20,20)
      COMMON/VIONIX/AMCOS, FRAV, FUCOS, INCOS, LUCOS(20), NAV,
     1              PQTY, RICOS, SUCOS(20,20), WT(20), WTB(20,20), XLRN,
     2              BMH(20), DMH(20), RTLB(20), LMTTR(20), SMTTR(20,20)
C
C    *DECLARE VARIABLES
C
      DIMENSION NSPRB(20,20),NSPRL(20),RNSEB(25),RNSED(25),SUF(3),
     1          AVALB(20),AVALD(20),LCOMB(20),LCOMD(20),NBPER(25),
     2          NDPER(25),NSEB(20),NSED(20),USECOB(20),USECOD(20),
     3          UTILB(20),UTILD(20)
      INTEGER XMIN3,YEAR
      REAL INCOS,JRTS,LMTBF,LUCOS,MTBFL,MTBFS,NNSEB(25),NRAC,
     1     NNSED(25),NRCOS, IAMC, MSEBO, MSEDO, NBPER, NDPER,
     2     NLSPRS, NPERB, NPERD, NS, NSPRB, NSPRL, NSSPRS, NSEB, NSED,
     3     NSEBY,NSEDY,LRUT,NAC,OWNER(25),LMTTR,LMKUP,SMKUP
      DATA NSPRL/20*0.0/, NRCOS/200*0.0/, RLCOS/200*0.0/
      DATA NSPRB/400*0.0/, RNSEB/25*0.0/, RNSED/25*0.0/
      DATA NNSED/25*0.0/, NNSEB/25*0.0/, OWNER/25*0.0/, NS/0.0/
      DATA NSEB/20*0.0/, NSED/20*0.0/, NBPER/25*0.0/, NDPER/25*0.0/
      DATA TNRCOS/25*0.0/, TRLCOS/25*0.0/, TCOSL/25*0.0/
      DATA TCOSN/25*0.0/, TCOSN/25*0.0/
      DATA LMKUP/1.00/, SMKUP/1.00/
C
C    *READ LOGISTIC SUPPORT DATA
C
      READ(2,1001) BIT,RTSS,ROP
      READ(3,1006) BSOBL,BSODL,OSBL,OSDL
      READ(3,1006) BSOB,BSOD,OSB,OSD
      READ(3,1001) FPM,PMMH,CPP,PACK
      READ(3,1001) YMIL,XMIL,SSHC,SHC
      READ(3,1001) ONAC,OFAC,STR,TFR
      READ(3,1005) IAMC,NIC,TIC
```

```
      READ(3,1001) HOLDB,HOLDD
      READ(3,1001) PRODB,PRODD,PMB,PMD
      READ(3,1002) BMT,DMT,NPBD,NPDD
      READ(3,1001) TCOSB,TCOSD,TRB,TRD
      READ(3,1001) BLR,DLR,FOCB,FOCD
      READ(3,1001) AFHR,PFHR,SUF(2),SUF(3)
      READ(3,1001) BETA,DETA
      READ(2,1003) NOIB,NOID
      READ(2,1001) BMHS,DMHS,SECOB,SECOD
      READ(2,1003) JSEB,JSED,MSEBO,MSEDO
C
      IF (JSEB .EQ. 0) GO TO 2
      DO 2 M = 1, JSEB
        READ(2,1004) AVALB(M),LCOMB(M),USECOB(M),UTILB(M)
2     CONTINUE
C
      IF (JSED .EQ. 0) GO TO 4
      DO 4 M = 1, JSED
        READ(2,1004) AVALD(M),LCOMD(M),USECOD(M),UTILD(M)
4     CONTINUE
      READ(2,1007) MINB,XMINB,MINSEB,MINSED
C
C    *INITIALIZE VARIABLES
C    *ASSUMING A MINIMUM OF ONE REPAIR PERSON PER MAINTENANCE SITE
C    *MINBP AND MINDP ARE BOTH SET TO 1.
C
      MINBP = 1
      MINDP = 1
      BASE = 0.0
      DEPOT = 0.0
      FBLRU = BIT + (1-BIT)*RTSS
C
C    *CALCULATE AMHB AND AMHD
C
      DO 8 I = 1, NLRU
        BASE = BASE + FBLRU*(BMH(I)*RTS(I) + RTLB(I)*LMTTR(I))/LMTBF(I)
        DEPOT=DEPOT+((1-BIT)*(1-RTSS)+FBLRU*(1-RTS(I))*DMH(I) +
     1         FBLRU*(1-RTLB(I))*LMTTR(I))/LMTBF(I)
        IF (NSRU(I) .EQ. 0) GO TO 5
        DO 5 J = 1, NSRU(I)
          BASE = BASE + RTS(I)*(RTSB(I,J)*SMTTR(I,J))/SMTBF(I,J)
          DEPOT=DEPOT+(((1-BIT)*(1-RTSS)+FBLRU*((1-RTS(I))+(RTS(I)*(1-
     1          RTSB(I,J)))))*SMTTR(I,J)/SMTBF(I,J))
5       CONTINUE
8     CONTINUE
      AMHB = UMTBF*(((1-BIT)*BMHS)/UMTBF + FBLRU*BASE)
      AMHD = UMTBF*(((1-BIT)*(1-RTSS)*DMHS/UMTBF) + DEPOT)
C
      DO 200 I = 1, NYRS
        NOB = NBAS(I)
        NOD = NDEP(I)
C
C      *CALCULATE NUMBER OF SYSTEMS OPERATING IN YEAR I
```

```
C
        NS = NS + NAV*CRFT(I)
C
C      *CALCULATE PEAK FLIGHT AND TOTAL FLIGHT OPERATING HOURS
C      *FOR AVIONICS SYSTEMS
C
        PFAV = 12*PFHR*NS
        TFAV = 12*AFHR*NS
C
C     **CALCULATE COST OF INITIAL AND REPLACEMENT SPARES
C
        DO 60 J = 1, NLRU
          MTBFL = LMTBF(J)
          JRTS = RTS(J)
C
C        *INVESTMENT LRUS (NONRECURRING)
C        *DETERMINE IF LRU IS REPAIRABLE OR NON-REPAIRABLE
C
          IF (ITWL(J) .EQ. 1) GO TO 10
C
C        *REPAIRABLE LRUS
C
          YDUM = TFAV*(FBLRU*JRTS*BMT)/(NOB*MTBFL)
          ZDUM = TFAV*(FBLRU*(1-JRTS)*DMT)/(NOD*MTBFL)
C
          BLRU = AINT(NOB*(YDUM + SUF(2)*SQRT(YDUM)))
          MINLRU = MINB*NOB/LCOML(J)
          IF (BLRU .LT. MINLRU) BLRU = MINLRU
C
          DLRU = AINT(NOD*(ZDUM + SUF(2)*SQRT(ZDUM)))
          MINLRU = MINB*NOD/LCOML(J)
          IF (DLRU .LT. MINLRU) DLRU = MINLRU
C
          NLSPRS = BLRU + DLRU - NSPRL(J)
          GO TO 20
C
C        *NON-REPAIRABLE LRUS
C
10        YDUM = TFAV*FBLRU*BSOBL/(NOB*MTBFL)
          ZDUM = TFAV*FBLRU*BSODL/(NOD*MTBFL)
          TDUM = TFAV*FBLRU*OSBL/MTBFL
          SDUM = TFAV*FBLRU*OSDL/MTBFL
          RDUM = TFAV*ROP/MTBFL
          NLSPRS = AINT(NOB*(YDUM+SUF(2)*SQRT(YDUM)))
     1           + AINT(NOD*(ZDUM+SUF(2)*SQRT(ZDUM)))
     2     + AINT(TDUM) + AINT(SDUM) + AINT(RDUM) - NSPRL(J)
20        NSPRL(J) = NSPRL(J) + NLSPRS
          NRCOS(I,1) = NRCOS(I,1) + NLSPRS*LUCOS(J)
C
C       *REPLENISHMENT LRUS (RECURRING)
C
          RLSPRS = AINT(TFAV*COND(J)/MTBFL)
          RLCOS(I,1) = RLCOS(I,1) + RLSPRS*LUCOS(J)*(1 + LMKUP)
```

```
C
C        *SRU INITIAL AND REPLACEMENT SPARES
C
           IF (NSRU(J) .EQ. 0) GO TO 50
           DO 50 K = 1, NSRU(J)
             MTBFS = SMTBF(J,K)
C
C           *INVESTMENT SRUS (NONRECURRING)
C           *DETERMINE IF SRU(J,K) IS REPAIRABLE OR NON-REPAIRABLE
C
             IF (ITWS(J,K) .EQ. 1) GO TO 30
C
C           *REPAIRABLE SRUS
C
             XDUM = TFAV*(FBLRU*JRTS*RTSB(J,K)*BMT)/(NOB*MTBFS)
             YDUM = TFAV*(FBLRU*(JRTS*(1-RTSB(J,K)) + (1-JRTS))*DMT)
     1         /(NOD*MTBFS)
C
             BSRU=AINT(NOB*(XDUM+SUF(3)*SQRT(XDUM)))
             MINSRU = (XMINB*NOB)/LCOMS(J,K)
             IF (BSRU .LT. MINSRU) BSRU = MINSRU
C
             DSRU = AINT(NOD*(YDUM+SUF(3)*SQRT(YDUM)))
             MINSRU = (XMINB*NOD/LCOMS(J,K))
             IF (DSRU .LT. MINSRU) DSRU = MINSRU
C
             NSSPRS = BSRU + DSRU - NSPRB(J,K)
             GO TO 40
C
C           *NON-REPAIRABLE SRUS
C
30           XDUM=TFAV*FBLRU*JRTS*BSOB/(NOB*MTBFS)
             YDUM = TFAV*FBLRU*(1-JRTS)*BSOD/(NOD*MTBFS)
             WDUM=TFAV*FBLRU*JRTS*OSB/MTBFS
             TDUM = TFAV*FBLRU*(1-JRTS)*OSD/MTBFS
             SDUM=TFAV*ROP/MTBFS
             NSSPRS = AINT(NOB*(XDUM+SUF(3)*SQRT(XDUM)))
     1         + AINT(NOD*(YDUM+SUF(3)*SQRT(YDUM)))
     2         + AINT(WDUM) + AINT(TDUM)
     3         + AINT(SDUM) - NSPRB(J,K)
40           NSPRB(J,K) = NSPRB(J,K) + NSSPRS
             NRCOS(I,1) = NRCOS(I,1) + NSSPRS*SUCOS(J,K)
C
C           *REPLENISHMENT SRUS (RECURRING)
C
             RSSPRS=AINT(TFAV*CONDB(J,K)/MTBFS)
             RLCOS(I,1) = RLCOS(I,1) + RSSPRS*SUCOS(J,K)*(1 + SMKUP)
50         CONTINUE
60       CONTINUE
C
C     **CALCULATE COSTS OF ON-AIRCRAFT MAINTENANCE
C
C      *NONRECURRING COSTS
```

```
C       *NRCOS(I,2) = 0.0
C
C       *RECURRING COSTS
C
         DO 70 J = 1, NLRU
           RLCOS(I,2) = RLCOS(I,2) + ((TFAV*RMHB(J)/LMTBF(J))
     1       + (NS*FPM*PMMH))*BLR
70       CONTINUE
C
C      **CALCULATE COSTS OF OFF-AIRCRAFT MAINTENANCE
C
C       *NONRECURRING COSTS
C       *NRCOS(I,3) = 0.0
C
C       *RECURRING COSTS
C       *RECURRING OFF-AIRCRAFT MAINTENANCE COSTS ARE COMPOSED OF
C       *FOUR SUB-COST CATEGORIES: MATERIALS, LABOR, SHIPPING, &
C       *DOCUMENTATION.
C       *INITIALIZE DUMMY VARIABLES TO ZERO
C
         XLMAT = 0.0
         XSMAT = 0.0
         XLREP = 0.0
         XSREP = 0.0
         XLSHP = 0.0
         XSSHP = 0.0
         XLTTR = 0.0
         XSTTR = 0.0
         LRUT = 0.0
         SRUT = 0.0
         BDOC = (ONAC + OFAC + STR)/UMTBF
         DDOC = (OFAC + STR)/UMTBF
C
C       *CALCULATE COSTS FOR LRU LEVEL OF MAINTENANCE
C       *CALCULATE INTERMEDIATE VALUES WITHIN THE LOOPS AND
C       *THE FINAL VALUES OUTSIDE THE LOOPS
C
         DO 90 J = 1, NLRU
           JRTS = RTS(J)
           MTBFL = LMTBF(J)
C
C         *MATERIALS--LRU(J)
C
           XLMAT = XLMAT + ((FBLRU*JRTS*RTLB(J)*BMC(J)) + (FBLRU*JRTS
     1               *(1-RTLB(J)) + FBLRU*(1-JRTS))*DMC(J))/MTBFL
C
C         *LABOR--LRU(J)
C
          XLREP = XLREP + FBLRU*JRTS*LMTTR(J)*(1-ITWL(J))*(RTLB(J)*BLR +
     +              (1-RTLB(J))*DLR)/MTBFL
C
C         *SHIPPING--LRU(J)
C
```

```
      XLSHP = XLSHP + (WT(J)*(FBLRU*((1-JRTS)+JRTS*(1-RTLB(J)))*2
     1        *YMIL*SSHC*(1-ITWL(J)) + (FBLRU*(1-JRTS)*(YMIL*SSHC+
     2        XMIL*SHC)*ITWL(J)))/MTBFL)
C
C    *WEIGHT OF EQUIPMENT SHIPPED TO REPLACE CONDEMNED LRU(J)
C
      XLTTR = XLTTR + WT(J)*COND(J)*(1-ITWL(J))/MTBFL
C
C    *DOCUMENTATION FOR MAINTENANCE--LRU(J)
C
      LRUT = LRUT + (FBLRU*(1-JRTS))/MTBFL
C
C    *CALCULATE COSTS FOR SRU LEVEL OF MAINTENANCE
C
      IF (NSRU(J) .EQ. 0) GO TO 80
      DO 80 K = 1, NSRU(J)
        XRTSB = RTSB(J,K)
        MTBFS = SMTBF(J,K)
C
C      *MATERIALS--SRU(J,K)
C
        XSMAT = XSMAT + ((FBLRU*JRTS*XRTSB*BMCS(J,K))+(FBLRU*(JRTS
     1          *(1-XRTSB)+(1-JRTS))*DMCS(J,K)))/MTBFS
C
C      *LABOR--SRU(J,K)
C
        XSREP = XSREP + ((FBLRU*JRTS*XRTSB*SMTTR(J,K)*BLR) +
     1          (FBLRU*(JRTS*(1-XRTSB)+(1-JRTS))*SMTTR(J,K)*DLR))
     2          *(1-ITWS(J,K))/MTBFS
C
C      *SHIPPING--SRU(J,K)
C
        XSSHP = XSSHP + (WTB(J,K)*((FBLRU*JRTS*(1-XRTSB)*2*YMIL*SSHC
     1          *(1-ITWS(J,K))) + (FBLRU*JRTS*(YMIL*SSHC+XMIL*SHC)
     2          *ITWS(J,K)))/MTBFS)
C
C      *WEIGHT OF EQUIPMENT SHIPPED TO REPLACE CONDEMNED SRU(J,K)
C
        XSTTR = XSTTR + WTB(J,K)*CONDB(J,K)*(1-ITWS(J,K))/MTBFS
C
C      *DOCUMENTATION FOR MAINTENANCE--SRU(J,K)
C
        SRUT = SRUT + (FBLRU*JRTS*(1-XRTSB))/MTBFS
80    CONTINUE
90   CONTINUE
C
C   *MAKE FINAL CALCULATIONS IN EACH SUB-CATEGORY
C   *COST OF MATERIALS
C
     TMAT = TFAV*(XLMAT + XSMAT)
C
C   *COST OF LABOR
C
```

```
      TLABOR = TFAV*(XLREP + XSREP)
C
C    *COST OF SHIPPING
C
      TSHIP = PACK*TFAV*((XLTTR + XSTTR)*(YMIL*SSHC + XMIL*SHC)
     1   + (XLSHP + XSSHP))
C
C    *COST OF MAINTENANCE DOCUMENTATION
C
C    *BASE LEVEL
C
      BDMTD = (BDOC + (LRUT+SRUT)*TFR)*TFAV*BLR
C
C    *DEPOT LEVEL
C
      DDMTD = (DDOC + (LRUT+SRUT)*TFR)*TFAV*DLR
C
C    *TOTAL OFF-AIRCRAFT MAINTENANCE RECURRING EXPENSE
C
      RLCOS(I,3) = RLCOS(I,3) + TMAT + TLABOR + TSHIP + BDMTD + DDMTD
C
C   **CALCULATE COSTS OF INVENTORY ENTRY AND SUPPLY MANAGEMENT
C
      NICB = 1
      IF (FRAV .EQ. 0.0) NICB = 0
C
C    *NONRECURRING COSTS
C
100   IF (I .NE. 1) GO TO 110
C
C    *IF (I .NE. 1) NRCOS(I,4) = 0.0
C
      NRCOS(I,4) = NRCOS(I,4) + IAMC*NIC*TIC*NICB
C
C    *RECURRING COSTS
C
      RLCOS(I,4) = RLCOS(I,4) + (NOB*NOIB*HOLDB + NOD*NOID*HOLDD
     1   )*NICB
      GO TO 115
110   RLCOS(I,4) = RLCOS(I,4) + (IAMC*NIC*TIC + NOB*NOIB*HOLDB +
     1               NOD*NOID*HOLDD)*NICB
C
C   **CALCULATE COSTS OF SPECIAL SUPPORT EQUIPMENT
C
C    *BASE SUPPORT EQUIPMENT
C
115   IF (JSEB .EQ. 0) GO TO 120
      DO 120 L = 1, JSEB
C
C      *NONRECURRING COSTS
C
        XNSEB = AINT(PFAV*BMH(1)*UTILB(L)/(LMTBF(1)*AVALB(L)*DETA))
        YNSEB = MINSEB*NOB/LCOMB(L)
```

```
      IF (XNSEB .LT. YNSEB) XNSEB = YNSEB
      NNSEB(I) = NNSEB(I) + ((XNSEB-NSEB(L))*USECOB(L))
      NSEB(L) = XNSEB
C
C      *RECURRING COSTS
C
      XRSEB = PFAV*BMH(1)*UTILB(L)*SECOB/(LMTBF(1)*AVALB(L)*DETA)
      YRSEB = MSEBO*NSEB(L)
      IF (XRSEB .LT. YRSEB) XRSEB = YRSEB
      RNSEB(I) = RNSEB(I) + XRSEB
120   CONTINUE
C
C     *DEPOT SUPPORT EQUIPMENT
C
      IF (JSED .EQ. 0) GO TO 130
      DO 130 L = 1, JSED
C
C      *NONRECURRING COSTS
C
      XNSED = AINT(PFAV*DMH(1)*UTILD(L)/(LMTBF(1)*AVALD(L)*DETA))
      YNSED = MINSED*NOD/LCOMD(L)
      IF (XNSED .LT. YNSED) XNSED = YNSED
      NNSED(I) = NNSED(I) + ((XNSED-NSED(L))*USECOD(L))
      NSED(L) = XNSED
C
C      *RECURRING COSTS
C
      XRSED = PFAV*DMH(1)*UTILD(L)*SECOD/(LMTBF(1)*AVALD(L)*DETA)
      YRSED = MSEDO*NSED(L)
      IF (XRSED .LT. YRSED) XRSED = YRSED
      RNSED(I) = RNSED(I) + XRSED
130   CONTINUE
C
C     *TOTAL NONRECURRING COST, SPECIAL SUPPORT EQUIPMENT
C
      NRCOS(I,5) = NRCOS(I,5) + NNSEB(I) + NNSED(I)
C
C     *TOTAL RECURRING COST, SPECIAL SUPPORT EQUIPMENT
C
      RLCOS(I,5) = RLCOS(I,5) + RNSEB(I) + RNSED(I)
C
C
C    **CALCULATE COST OF TRAINING PERSONNEL
C
C     *NONRECURRING COSTS (INITIAL TRAINING)
C     *BASE LEVEL
C
      XBPER = AINT((TFAV*AMHB/(PMB*PRODB*UMTBF)))
      YBPER = MINBP*NOB
      IF (XBPER .LT. YBPER) XBPER = YBPER
      NBPER(I) = NBPER(I) + (XBPER - NPERB)
C
C     *DEPOT LEVEL
```

```
      XDPER = AINT((TFAV*AMHD/(PMD*PRODD*UMTBF)))
      YDPER = MINDP*NOD
      IF (XDPER .LT. YDPER) XDPER = YDPER
      NDPER(I) = NDPER(I) + (XDPER - NPERD)
C
C    *TOTAL NONRECURRING
C
      NRCOS(I,6) = NRCOS(I,6) + NBPER(I)*TCOSB + NDPER(I)*TCOSD
C
C    *RECURRING COST (DUE TO PERSONNEL TURNOVER)
C
      RLCOS(I,6) = RLCOS(I,6) + NPERB*TCOSB*TRB + NPERD*TCOSD*TRD
      NPERB = XBPER
      NPERD = XDPER
C
C
C   **CALCULATE COSTS OF DATA MANAGEMENT AND TECHNICAL DOCUMENTATION
C
C    *NONRECURRING COSTS
C
      IF (I .NE. 1) GO TO 135
      NNBAS = NOB
      NNDEP = NOD
      GO TO 137
135   NNBAS = NOB - NBAS(I-1)
      NNDEP = NOD - NDEP(I-1)
137   NRCOS(I,7) = NRCOS(I,7) + CPP*(NPBD*NNBAS + NPDD*NNDEP)
C
C    *RECURRING COSTS
C    *RLCOS(I,7) = 0.0
C
C
C   **CALCULATE COST OF FACILITIES
C
C     *NONRECURRING COSTS
C     *NRCOS(I,8) = 0.0
C
C    *RECURRING COSTS
C
      RLCOS(I,8) = RLCOS(I,8) + FOCB*NOB + FOCD*NOD
C
C   *TOTAL NONRECURRING AND RECURING LOGISTICS COSTS FOR YEAR I
C
      DO 160 J = 1, 8
        TNRCOS(I) = TNRCOS(I) + NRCOS(I,J)
        TRLCOS(I) = TRLCOS(I) + RLCOS(I,J)
160   CONTINUE
CC    *TOTAL LOGISTIC COSTS FOR YEAR I
C
      TLLCOS(I) = TNRCOS(I) + TRLCOS(I)
200  CONTINUE
C
C   *FORMAT STATEMENTS
```

```
C
1001  FORMAT(10X,F8.2,3(7X,F8.2))
1002  FORMAT(10X,F8.3,7X,F8.3,2(7X,I8))
1003  FORMAT(10X,I8,7X,I8,2(7X,F8.2))
1004  FORMAT(10X,F8.2,7X,I8,2(7X,F8.2))
1005  FORMAT(10X,F8.2,2(7X,I8))
1006  FORMAT(10X,4(F8.3,7X))
1007  FORMAT(3X,4(7X,I8))
C
      RETURN
      END
```

```
C                              SUBROUTINE PERGAC
C
C         THE PERGAC MODULE CALCULATES THE COST PER GA OWNER AND THE COST
C         PER GENERAL AVIATION AIRCRAFT FOR EACH YEAR IN THE LIFE CYCLE OF
C          THE SPECIFIED AVIONICS EQUIPMENT.
C
       SUBROUTINE PERGAC(NYRS,DSCNT)
C
C     *ESTABLISH COMMON BLOCKS
C
       COMMON/ACQUIZ/ACOS(25), TCOSA(25)
       COMMON/ARCRFT/CRFT(25), NAC(25), NRAC(25), YEAR(25)
       COMMON/INSTAL/ICOS(25), TCOSI(25)
       COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
      1             TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
       COMMON/NAMES/SNAME, UNAME
C
C     *DECLARE VARIABLES
C
       INTEGER LB, NYRS, UB, YEAR
       REAL ACOS,CLCC,CRFT,ICOS,NAC,NNAC,NRAC,NRCOS
       REAL PEROWN(25),RLCOS,TCOSA,TCOSI,TCOSL,TLCOS,TLLCOS
       REAL TNRCOS,TRLCOS,NCRFT,PERAC(25)
       LOGICAL*1 SNAME(65),UNAME(35)
C
C     *INITIALIZE VARIABLES
C
       TLCOS = 0.0
       NCRFT = 0.0
C
       DO 10 I = 1, NYRS
C
C       *CALCULATE COST PER OWNER OF AVIONICS EQUIPMENT
C       *NOTE: THE TOTAL LOGISTIC COSTS INCURRED BY THE GA OWNER ARE
C          RESTRICTED TO RECURRING MAINTENANCE.
C
         NCRFT = NCRFT + CRFT(I)
         PERAC(I) = (TCOSN(I) + TRLCOS(I))/NCRFT
         PEROWN(I)  = TRLCOS(I)/NCRFT
10     CONTINUE
C
C     *PRINT RESULTS
C
       WRITE(6,1005) (SNAME(I), I = 1, 65)
       WRITE(6,1006) (UNAME(I), I = 1, 35)
       WRITE(6,1007) DSCNT
       WRITE(6,1001)
       LB = 1
       UB = 3
       N0 = NYRS/UB
       N1 = 1
       N2 = N0
       DO 20 I = LB, UB
```

```
      WRITE(6,1002) (YEAR(J), J = N1, N2)
      WRITE(6,1004) (PERAC(J), J = N1, N2)
      WRITE(6,1003) (PEROWN(J), J = N1, N2)
      N1 = N1 + NO
      N2 = N2 + NO
      IF (N2 .GT. NYRS) N2 = NYRS
20    CONTINUE
C
C    *FORMAT STATEMENTS
C
1001  FORMAT(1X,//,59X,'AVIONICS COST PER YEAR',/)
1002  FORMAT(1X,//,28X,7(6X,I4,5X))
1003  FORMAT(9X,'COST PER OWNER ', 7(2X,F13.2))
1004  FORMAT(9X,'COST PER A/C    ', 7(2X,F13.2))
1005  FORMAT(1H1,///,4X,'SYSTEM: ',65A1)
1006  FORMAT(4X,'USER:      ',35A1)
1007  FORMAT(4X,'DISCOUNT FACTOR:',F4.2)
      RETURN
      END
```

SUBROUTINE TOTCUM

```
C
C
C       THE TOTCUM MODULE CALCULATES THE TOTAL LOGISTIC SUPPORT
C       COSTS INCURRED EACH YEAR AND THE CUMULATIVE ACQUISITION,
C       INSTALLATION, AND LOGISTIC SUPPORT COSTS INCURRED PRIOR TO
C       YEAR I.
C
      SUBROUTINE TOTCUM(NYRS)
C
C    *ESTABLISH COMMON BLOCKS
C
      COMMON/ACQUIZ/ACOS(25), TCOSA(25)
      COMMON/ARCRFT/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/CAT/CLCC, TNRCAT(9), TRLCAT(9), TPROG(25), CPROG(25)
      COMMON/INSTAL/ICOS(25), TCOSI(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
     1              TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
C
C    *DECLARE VARIABLES
C
      INTEGER YEAR
      REAL ICOS, NAC, NRCOS, NRAC
C
C    *INITIALIZE VARIABLES
C
      DO 1 I = 1, NYRS
        TCOSA(I) = 0.0
        TCOSI(I) = 0.0
        TCOSN(I) = 0.0
        TCOSR(I) = 0.0
        TCOSL(I) = 0.0
        CPROG(I) = 0.0
1     CONTINUE
      DO 2 J = 1, 9
        TNRCAT(J) = 0.0
        TRLCAT(J) = 0.0
2     CONTINUE
      CLCC = 0.0
C
      DO 30 I = 1, NYRS
        DO 10 J = I, NYRS
C
C          *DETERMINE CUMULATIVE ACQUISITION COSTS
C
            TCOSA(J) = TCOSA(J) + ACOS(I)
C
C          *DETERMINE CUMULATIVE INSTALLATION COSTS
C
            TCOSI(J) = TCOSI(J) + ICOS(I)
C
C          *DETERMINE CUMULATIVE LOGISTIC SUPPORT COSTS
C
            TCOSN(J) = TCOSN(J) + TNRCOS(I)
```

```
          TCOSR(J) = TCOSR(J) + TRLCOS(I)
          TCOSL(J) = TCOSL(J) + TLLCOS(I)
C
C        *DETERMINE CUMULATIVE PROGRAM COSTS
C
          CPROG(J) = CPROG(J) + ACOS(I) + ICOS(I) + TLLCOS(I)
10      CONTINUE
C
C       *DETERMINE TOTAL PROGRAM COST FOR YEAR I
C
        TPROG(I) = TLLCOS(I) + ACOS(I) + ICOS(I)
C
C       *DETERMINE CUMULATIVE PROGRAM COST
C
        CLCC = CLCC + TPROG(I)
C
C       *DETERMINE TOTAL FOR EACH LOGISTIC CATEGORY
C
        DO 20 J = 1, 8
          TNRCAT(J) = TNRCAT(J) + NRCOS(I,J)
          TNRCAT(9) = TNRCAT(9) + NRCOS(I,J)
          TRLCAT(J) = TRLCAT(J) + RLCOS(I,J)
          TRLCAT(9) = TRLCAT(9) + RLCOS(I,J)
20      CONTINUE
30    CONTINUE
C
      RETURN
      END
```

```
C                          SUBROUTINE OUTTAB
C
C           THE OUTTAB MODULE OUTPUTS ALL OF THE VALUES COMPUTED IN
C           THE LIFE CYCLE COSTING MODEL IN TABULAR FORM.
C
      SUBROUTINE OUTTAB(NYRS,DSCNT)
C
C     *ESTABLISH COMMON BLOCKS
C
      COMMON/ACQUIZ/ACOS(25), TCOSA(25)
      COMMON/ARCRFT/CRFT(25), NAC(25), NRAC(25), YEAR(25)
      COMMON/CAT/CLCC, TNRCAT(9), TRLCAT(9), TPROG(25), CPROG(25)
      COMMON/INSTAL/ICOS(25), TCOSI(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
     1              TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
      COMMON/NAMES/SNAME,UNAME
C
C     *DECLARE VARIABLES
C
      INTEGER YEAR,UB
      REAL ICOS, NRAC, NAC, NRCOS
      LOGICAL*1 ANS, SNAME(65), UNAME(35)
C
C     *INITIALIZE VARIABLES
C
      NO = NYRS/3
      LB = 1
      UB = 2
C
      WRITE(1,*) 'DO YOU WANT A NONRECURRING/RECURRING COST BREAKDOWN?'
      READ(1,1050) ANS
      IF (ANS .NE. 'Y') GO TO 27
C     *PRINT HEADINGS, INVESTMENT COSTS
C
      WRITE(6,1034) (SNAME(I), I = 1,65)
      WRITE(6,1035) (UNAME(I), I = 1,35)
      WRITE(6,1036) DSCNT
      WRITE(6,1000)
      N1 = 1
      N2 = NO
C
C     *PRINT NONRECURRING COSTS FOR EACH YEAR BY CATEGORY
C
      DO 10 I = LB, UB
        WRITE(6,1001) (YEAR(J), J = N1, N2)
        WRITE(6,1002) (NRCOS(J,1), J = N1, N2)
        WRITE(6,1005) (NRCOS(J,4), J = N1, N2)
        WRITE(6,1006) (NRCOS(J,5), J = N1, N2)
        WRITE(6,1007) (NRCOS(J,6), J = N1, N2)
        WRITE(6,1008) (NRCOS(J,7), J = N1, N2)
        WRITE(6,1009) (NRCOS(J,8), J = N1, N2)
        WRITE(6,1010) (TNRCOS(J), J = N1, N2)
        N1 = N1 + NO
```

```
        N2 = N2 + NO
        IF (N2 .LT. NYRS) GO TO 10
        N2 = NYRS
        GO TO 15
 10   CONTINUE
 15   WRITE(6,1026) (YEAR(J),J = N1, N2)
      WRITE(6,1027)
      WRITE(6,1012) (NRCOS(J,1), J = N1, N2)
      WRITE(6,1013) TNRCAT(1)
      WRITE(6,1016) (NRCOS(J,4), J = N1, N2)
      WRITE(6,1013) TNRCAT(4)
      WRITE(6,1017) (NRCOS(J,5), J = N1, N2)
      WRITE(6,1013) TNRCAT(5)
      WRITE(6,1018) (NRCOS(J,6), J = N1, N2)
      WRITE(1,1013) TNRCAT(6)
      WRITE(6,1019) (NRCOS(J,7), J = N1, N2)
      WRITE(6,1013) TNRCAT(7)
      WRITE(6,1020) (NRCOS(J,8), J = N1, N2)
      WRITE(6,1013) TNRCAT(8)
      WRITE(6,1021) (TNRCOS(J), J = N1, N2)
      WRITE(6,1013) TNRCAT(9)
C
C    *PRINT HEADINGS, OPERATING AND SUPPORT COSTS
C
      WRITE(6,1034) (SNAME(I), I = 1, 65)
      WRITE(6,1035) (UNAME(I), I = 1, 35)
      WRITE(6,1036) DSCNT
      WRITE(6,1028)
      N1 = 1
      N2 = NO
C
C    *PRINT RECURRING COSTS FOR EACH CATEGORY BY YEAR
C
      DO 20 I = LB, UB
        WRITE(6,1001) (YEAR(J), J = N1, N2)
        WRITE(6,1002) (RLCOS(J,1), J = N1, N2)
        WRITE(6,1003) (RLCOS(J,2), J = N1, N2)
        WRITE(6,1004) (RLCOS(J,3), J = N1, N2)
        WRITE(6,1005) (RLCOS(J,4), J = N1, N2)
        WRITE(6,1006) (RLCOS(J,5), J = N1, N2)
        WRITE(6,1007) (RLCOS(J,6), J = N1, N2)
        WRITE(6,1008) (RLCOS(J,7), J = N1, N2)
        WRITE(6,1009) (RLCOS(J,8), J = N1, N2)
        WRITE(6,1010) (TRLCOS(J), J = N1, N2)
        N1 = N1 + NO
        N2 = N2 + NO
        IF (N2 .LT. NYRS) GO TO 20
        N2 = NYRS
        GO TO 25
 20   CONTINUE
 25   WRITE(6,1026) (YEAR(J), J = N1, N2)
```

```
      WRITE(6,1027)
      WRITE(6,1012) (RLCOS(J,1), J = N1, N2)
      WRITE(6,1013) TRLCAT(1)
      WRITE(6,1014) (RLCOS(J,2), J = N1, N2)
      WRITE(6,1013) TRLCAT(2)
      WRITE(6,1015) (RLCOS(J,3), J = N1, N2)
      WRITE(6,1013) TRLCAT(3)
      WRITE(6,1016) (RLCOS(J,4), J = N1, N2)
      WRITE(6,1013) TRLCAT(4)
      WRITE(6,1017) (RLCOS(J,5), J = N1, N2)
      WRITE(6,1013) TRLCAT(5)
      WRITE(6,1018) (RLCOS(J,6), J = N1, N2)
      WRITE(6,1013) TRLCAT(6)
      WRITE(6,1019) (RLCOS(J,7), J = N1, N2)
      WRITE(6,1013) TRLCAT(7)
      WRITE(6,1020) (RLCOS(J,8), J = N1, N2)
      WRITE(6,1013) TRLCAT(8)
      WRITE(6,1021) (TRLCOS(J), J = N1, N2)
      WRITE(6,1013) TRLCAT(9)
C
C     *PRINT HEADINGS FOR TOTAL LIFE CYCLE COSTS BY YEAR
C
27    WRITE(6,1034) ([illegible](I), I = 1, 65)
      WRITE(6,1035) ([illegible](I), I = 1, 35)
      WRITE(6,1036) DSCRT
      WRITE(6,1029)
      N1 = 1
      N2 = NO
C
C     *PRINT RESULTS
C
      DO 30 I = LB, UB
        WRITE(6,1001) (YEAR(J), J = N1, N2)
        WRITE(6,1030) (ACOS(J), J = N1, N2)
        WRITE(6,1031) (ICOS(J), J = N1, N2)
        WRITE(6,1037) (TNRCOS(J), J = N1, N2)
        WRITE(6,1038) (TRLCOS(J), J = N1, N2)
        WRITE(6,1032) (TLLCOS(J), J = N1, N2)
        WRITE(6,1033) (TPROG(J), J = N1, N2)
        N1 = N1 + NO
        N2 = N2 + NO
        IF (N2 .LT. NYRS) GO TO 30
        N2 = NYRS
        GO TO 35
30    CONTINUE
35    WRITE(6,1026) (YEAR(J), J = N1, N2)
      WRITE(6,1027)
      WRITE(6,1022) (ACOS(J), J = N1, N2)
      WRITE(6,1013) TCOSA(NYRS)
      WRITE(6,1023) (ICOS(J), J = N1, N2)
      WRITE(6,1013) TCOSI(NYRS)
      WRITE(6,1040) (TNRCOS(J), J = N1, N2)
      WRITE(6,1013) TCOSN(NYRS)
```

```
      WRITE(6,1041) (TRLCOS(J), J = N1, N2)
      WRITE(6,1013) TCOSR(NYRS)
      WRITE(6,1024) (TLLCOS(J), J = N1, N2)
      WRITE(6,1013) TCOSL(NYRS)
      WRITE(6,1025) (TPROG(J), J = N1, N2)
      WRITE(6,1013) CLCC
C
C     *PRINT HEADINGS FOR CUMULATIVE LIFE CYCLE COSTS BY YEAR
C
      WRITE(6,1039)
      N1 = 1
      N2 = NO
C
C     *PRINT RESULTS
C
      DO 40 I = LB, UB+1
        WRITE(6,1001) (YEAR(J), J = N1, N2)
        WRITE(6,1030) (TCOSA(J), J = N1, N2)
        WRITE(6,1031) (TCOSI(J), J = N1, N2)
        WRITE(6,1037) (TCOSN(J), J = N1, N2)
        WRITE(6,1038) (TCOSR(J), J = N1, N2)
        WRITE(6,1032) (TCOSL(J), J = N1, N2)
        WRITE(6,1033) (CPROG(J), J = N1, N2)
        N1 = N1 + NO
        N2 = N2 + NO
        IF (N2 .LT. NYRS) GO TO 40
        N2 = NYRS
40    CONTINUE
C
C     *FORMAT STATEMENTS
C
1000  FORMAT(49X,'NONRECURRING LOGISTIC SUPPORT COSTS',//)
1001  FORMAT(1X,//,9X,'COST CATEGORY   ', 2X, 7(6X,I4,5X),/)
1002  FORMAT(9X,'SPARES          ', 8(2X,F13.0))
1003  FORMAT(9X,'ON-A/C MAINT    ', 8(2X,F13.0))
1004  FORMAT(9X,'OFF-A/C MAINT   ', 8(2X,F13.0))
1005  FORMAT(9X,'INVENTORY MGT   ', 8(2X,F13.0))
1006  FORMAT(9X,'SUPPORT EQUIP   ', 8(2X,F13.0))
1007  FORMAT(9X,'TRAINING        ', 8(2X,F13.0))
1008  FORMAT(9X,'DATA MANAGEMENT', 8(2X,F13.0))
1009  FORMAT(9X,'FACILITIES      ', 8(2X,F13.0))
1010  FORMAT(9X,'ANNUAL TOTAL    ', 8(2X,F13.0))
1012  FORMAT('$',8X,'SPARES          ',8(2X,F13.0))
1013  FORMAT('+',2X,F13.0)
1014  FORMAT('$',8X,'ON-A/C MAINT    ',8(2X,F13.0))
1015  FORMAT('$',8X,'OFF-A/C MAINT   ',8(2X,F13.0))
1016  FORMAT('$',8X,'INVENTORY MGT   ',8(2X,F13.0))
1017  FORMAT('$',8X,'SUPPORT EQUIP   ',8(2X,F13.0))
1018  FORMAT('$',8X,'TRAINING        ',8(2X,F13.0))
1019  FORMAT('$',8X,'DATA MANAGEMENT',8(2X,F13.0))
1020  FORMAT('$',8X,'FACILITIES      ',8(2X,F13.0))
1021  FORMAT('$',8X,'ANNUAL TOTAL    ',8(2X,F13.0))
1022  FORMAT('$',8X,'ACQUISITION     ',8(2X,F13.0))
```

```
1023  FORMAT('$',8X,'INSTALLATION    ',8(2X,F13.0))
1024  FORMAT('$',8X,'TOTAL LOGISTIC  ',8(2X,F13.0))
1025  FORMAT('$',8X,'TOTAL PROGRAM   ',8(2X,F13.0))
1026  FORMAT(1X,//,'$',8X,'COST CATEGORY   ',2X,7(6X,I4,5X))
1027  FORMAT('+',2X,'TOTAL')
1028  FORMAT(52X,'RECURRING LOGISTIC SUPPORT COSTS',//)
1029  FORMAT(56X,'TOTAL LIFE CYCLE COSTS BY YEAR')
1030  FORMAT(9X,'ACQUISITION     ',8(2X,F13.0))
1031  FORMAT(9X,'INSTALLATION    ',8(2X,F13.0))
1032  FORMAT(9X,'TOTAL LOGISTIC  ',8(2X,F13.0))
1033  FORMAT(9X,'TOTAL PROGRAM   ',8(2X,F13.0))
1034  FORMAT(1H1,3X,'SYSTEM: ',65A1)
1035  FORMAT(4X,'USER:      ',35A1)
1036  FORMAT(4X,'DISCOUNT FACTOR:',F4.2)
1037  FORMAT(9X,'NONRECURRING    ',8(2X,F13.0))
1038  FORMAT(9X,'RECURRING       ',8(2X,F13.0))
1039  FORMAT(1X,//,50X,'CUMULATIVE LIFE CYCLE COSTS BY YEAR')
1040  FORMAT('$',8X,'NONRECURRING    ',8(2X,F13.0))
1041  FORMAT('$',8X,'RECURRING       ',8(2X,F13.0))
1050  FORMAT(10A1)
      RETURN
      END
```

```
C                           SUBROUTINE DISCNT
C
C        THE DISCNT MODULE DISCOUNTS THE ACQUISITION, INSTALLATION,
C        NONRECURRING AND RECCURRING LOGISTIC COSTS FOR ALL YEARS
C        AND CATEGORIES.
C        *NOTE: THE CONSTANT DOLLAR COST ARRAY VALUES ARE CHANGED
C        DUE TO THE USE OF THE COMMON STATEMENT.
C
      SUBROUTINE DISCNT(NYRS,XDIS,BASEYR)
C
C     *ESTABLISH COMMON BLOCKS
C
      COMMON/ACQUIZ/ACOS(25), TCOSA(25)
      COMMON/ARCRFT/CRFT(25),NAC(25),NRAC(25),YEAR(25)
      COMMON/INSTAL/ICOS(25), TCOSI(25)
      COMMON/LOGIST/NRCOS(25,8), RLCOS(25,8), TCOSL(25), TLLCOS(25),
     1              TNRCOS(25), TRLCOS(25), TCOSN(25), TCOSR(25)
      COMMON/CAT/CLCC, TNRCAT(9), TRLCAT(9), TPROG(25), CPROG(25)
C
C     *DECLARE VARIABLES
C
      INTEGER BASEYR,YEAR
      REAL ICOS, NRCOS, NAC, NRAC
C
      DO 20 I = 1, NYRS
C
C      *COMPUTE THE DISCOUNT FACTOR FOR YEAR I
C
        N = YEAR(I) - BASEYR
        DISC = (1/(1+XDIS))**N
C
C      *DISCOUNT ALL COST ARRAYS
C
        ACOS(I) = ACOS(I)*DISC
        ICOS(I) = ICOS(I)*DISC
        TPROG(I) = TPROG(I)*DISC
        TNRCOS(I) = TNRCOS(I)*DISC
        TRLCOS(I) = TRLCOS(I)*DISC
        TLLCOS(I) = TLLCOS(I)*DISC
        DO 10 J = 1, 8
          NRCOS(I,J) = NRCOS(I,J)*DISC
          RLCOS(I,J) = RLCOS(I,J)*DISC
10      CONTINUE
20    CONTINUE
C
      RETURN
      END
```

APPENDIX D

LIFE-CYCLE-COST MODEL PARAMETER SUMMARY

VARIABLE	DESCRIPTION	VALUE
AFHR	Average flight hours per month per A/C	15.8 hrs.
AMCOS	Amortization cost	0 (100K per LSI)
$AVALB_L$	Availability of Lth type base support equipment	1
$AVALD_L$	Availability of Lth type depot support equipment	1
BETA	Base support equipment time available per month (hrs)	160 hrs.
BIT	Fraction of failures isolated to LRU by Built-In Test Equipment	0
BLR	Base labor rate ($/hr)	$25.25/hr.
BMC_J	Average base materials cost per maintenance action on Jth LRU	System Variable
$BMCS_{J,K}$	Average base materials cost per maintenance action on Kth SRU in Jth LRU	System Variable
BMH_J	Average labor-hours to isolate LRU_J failure to SRU level base	System Variable
BMHS	Average labor-hours to isolate failure to LRU, base	0.5
BMT	Average base turnaround time (mo.)	0.033
BSOB	Base SRU stocking objective (mo.)	N/A
BSOBL	Base LRU stocking objective (mo.)	N/A
BSOD	Depot SRU stocking objective (mo.)	N/A
BSODL	Depot LRU stocking objective (mo.)	N/A
$COND_J$	Fraction LRU_J failures resulting in condemnations	System Variable
$CONDB_{J,K}$	Fraction $SRU_{J,K}$ failures resulting in condemnations	System Variable

NOTE: "Base" represents any FAA certified avionics repair facility.
"Depot" represents any DABS manufacturer

VARIABLE	DESCRIPTION	VALUE
CPP	Cost per page, original technical documentation	N/A
DETA	Depot support equipment time available per month (hrs)	160 hrs.
DIST	Percentage mark-up by distributors on full unit	0.60
DLR	Depot labor rate	$27.76/hr.
DMC_J	Average depot materials cost per maintenance action on Jth LRU	System Variable
$DMCS_{J,K}$	Average depot materials cost per maintenance action on Kth SRU in Jth LRU	System Variable
DMH_J	Average labor-hours to isolate LRU_J failure to SRU level, depot	System Variable
DMHS	Average labor-hours to isolate failure to LRU level, depot	0.25
DMT	Depot turnaround time (mo.)	.268 mo.
FOCB	Annual base facilities cost attributable to system being analyzed	N/A
FOCD	Annual depot facilities cost attributable to system being analyzed	N/A
FPM	Annual frequency of preventive maintenance	N/A
FRAV	Fraction of A/C in user category having specified avionics	1.0
FUCOS	Average sell price less amortization of avionics unit	System Variable
HOLDB	Average annual holding cost per item type, base	N/A
HOLDD	Average annual holding cost per item type, depot	N/A
IAMC	Cost of introducing each new inventory coded item	N/A
INCOS	Installation cost of avionics in new A/C	$195
$ITWL_J$	Repair/throw-away flag for Jth LRU	System Variable
JSEB	Number of different types of base support equipment	System Variable

VARIABLE	DESCRIPTION	VALUE
JSED	Number of different types of depot support equipment	System Variable
$LCOMB_L$	Number avionics unit types to which Lth type base support equipment is common	1
$LCOMD_L$	Number avionics unit types to which Lth type depot support equipment is common	1
$LCOML_J$	Number avionics unit types to which Jth LRU is common	1
$LCOMS_{J,K}$	Number avionics unit type to which $SRU_{J,K}$ is common	1
LDIST	Percentage mark-up by distributors on LRUs	0.0
$LMTBF_J$	Mean time between failures (MTBF) of Jth LRU	System Variable
$LMTTR_J$	Mean time to repair LRU_J	System Variable
$LUCOS_J$	Unit cost of Jth LRU	System Variable
MINSEB	Minimum number support equipment sets per type per base	1
MINSED	Minimum number support equipment sets per type per depot	1
MSEBO	Minimum annual support equipment operating cost, base	N/A
MSEDO	Minimum annual support equipment operating cost, depot	N/A
NAV	Average number avionics units per A/C	1
NIC	Fraction of inventory coded items that are new	N/A
NLRU	Number LRUs per avionics unit	2
$NNAC_I$	Number of new A/C in user category in year I	12,850
NNB	Number new bases added each year	15
NND	Number new depots added each year	0

VARIABLE	DESCRIPTION	VALUE
NOBAS	Number of bases in first year of life cycle	50
NODEP	Number of depots in first year of life cycle	8
NOIB	Number different item types stocked at base	N/A
NOID	Number different item types stocked at depot	N/A
NPBD	Number pages base level documentation	N/A
NPDD	Number pages depot level documentation	N/A
$NSRU_J$	Number of SRUs in Jth LRU	System Variable
NUM	Number of systems to be evaluated in program run (user input)	1
NYRS	Number years in life cycle	15
OFAC	Average time to complete off-A/C maintenance records	.24 hrs.
ONAC	Average time to complete on A/C maintenance records	N/A
OSB	Average SRU order/ship time, base (mo.)	.134
OSBL	Average LRU order/ship time, base (mo.)	.134
OSD	Average SRU order/ship time, depot (mo.)	N/A
OSDL	Average order/ship time, LRU, depot (mo.)	N/A
PACK	Packaging factor (packed wt/unpacked wt.)	1.125
PFHR	Peak flight hours per month per A/C	18.9 hrs.
PMB	Available hours per year per man, base	2080
PMD	Available hours per year per man, depot	2080

VARIABLE	DESCRIPTION	VALUE
PMMH	Average labor-hours per preventive maintenance action	N/A
PQTY	Production lot size per manufacturer per year	3500
PRODB	Productivity of base repair personnel	.86
PRODD	Productivity of depot repair personnel	.86
RICOS	Retrofit cost of avionics	$264.
$RMHB_J$	Average labor-hours to remove and replace LRU_J, base	System Variable
ROP	Requirements objectives period	N/A
$RTLB_J$	Fraction LRU_J failures repaired at base	1.0
RTS_J	Fraction LRU_J failures isolated to SRU at base	System Variable
$RTSB_{J,K}$	Fraction repairable $SRU_{J,K}$ repaired at base	System Variable
RTSS	Fraction of failures isolated to LRU at base	1.0
SDIST	Percentage markup by distributors on SRUs	0.35
SECOB	Support equipment operating cost, base	N/A
SECOD	Support equipment operating cost, depot	N/A
SHC	Shipping rate, first destination ($/lb.-zone)	$1.37
$SMTBF_{J,K}$	MTBF of Kth SRU in Jth LRU	System Variable
$SMTTR_{J,K}$	Mean time to repair $SRU_{J,K}$	System Variable
SSHC	Shipping rate between base and depot ($/lb.-zone)	$1.37
STR	Average time to complete supply transaction records	.25 hrs.
$SUCOS_{J,K}$	Unit cost of $SRU_{J,K}$	System Variable

VARIABLE	DESCRIPTION	VALUE
SUF(2)	LRU spares sufficiency factor	.50
SUF(3)	SRU spares sufficiency factor	.50
TCOSB	Training cost per base repair person	N/A
TCOSD	Training cost per depot repair person	N/A
TFR	Average time to complete transportation forms	.16 hrs.
TIC	Total number of inventory coded items in stock	N/A
$TNRAC_I$	Number A/C to be retrofit in user category, year I	14896
TRB	Personnel turnover rate, base	N/A
TRD	Personnel turnover rate, depot	N/A
UMTBF	MTBF of avionics unit	System Variable
$USECOB_L$	Unit cost of Lth type base support equipment	System Variable
$USECOD_L$	Unit cost of Lth type depot support equipment	System Variable
$UTILB_L$	Utilization rate, Lth type base support equipment	System Variable
$UTILD_L$	Utilization rate, Lth type depot support equipment	System Variable
WT_J	Weight of Jth LRU (lb.)	System Variable
$WTB_{J,K}$	Weight of Kth SRU in Jth LRU (lb.)	System Variable
XDIS	Discount rate	.10
XMIL	Average number of shipping zones to first destination	N/A
XMINB	Minimum number each type SRU spares per base	1
XLRN	Learning curve factor	.875

VARIABLE	DESCRIPTION	VALUE
XMINBP	Minimum number base repair personnel	1
XMINDP	Minimum number depot repair personnel	1
XMINLB	Minimum number each type LRU spare per base	1
YMIL	Average number of shipping zones between base and depot	1

APPENDIX E

DISCRETE ADDRESS BEACON SYSTEM TRANSPONDER LOGIC DESIGNS

1.0 BASELINE DABS WITH COMM A AND COMM B E-3

2.0 ATARS E-32

3.0 EXTENDED LENGTH MESSAGES E-39

APPENDIX E

DISCRETE ADDRESS BEACON SYSTEM TRANSPONDER LOGIC DESIGNS

1.0 BASELINE DABS WITH COMM A AND COMM B

The baseline DABS transponder was designed to meet minimum surveillance criteria. This transponder would have the same capability as the present ATCRBS transponder, but additionally, it would be able to respond to BCAS surveillance interrogations (Uplink Formats 0 and 2), the DABS All-Call interrogation (Uplink Format 11), an altitude interrogation (Uplink Format 4), and an identification interrogation (Uplink Format 5). The baseline DABS transponder would also have the capability of generating unsolicited replies (squitters) which are necessary for BCAS purposes. Expansion of the baseline DABS transponder data field to 112 bits provides an additional 56 bits of data for various communication functions while performing all of the surveillance-associated functions of the baseline design. The expansion to include 56 additional bits (Comm A and Comm B capability) affects only the encode/decode design of the transponder and the power supply capacity.

The circuitry described in the following sections covers the logic elements necessary to decode an interrogation and to generate a response. It does not cover the radio frequency circuitry necessary for full transponder operation. Since the changes in DABS brought about by the new standard are mostly in the realm of data processing and manipulation, it is this area that is discussed in the following sections.

1.1 Transponder Capability

The basic DABS transponder has been designed to detect interrogations and respond as follows:

Interrogation:	Response:
ATCRBS (ALL)	ATCRBS (ALL)
ATCRBS/DABS All-Call	DABS All-Call (DF11)
ATCRBS Only All-Call	None
DABS Short Special Surveillance (UFO)	DABS Reply (DFO)
DABS Short Synchronous Surveillance (UF2)	DABS Reply (DF2)

Interrogation:	Response:
DABS Only All-Call (UF11)	DABS-Only All-Call (DF11)
DABS Altitude (UF4)	DABS Altitude (DF4)
DABS Identity (UF5)	DABS Identity (DF5)
All Other DABS	None

UF - Uplink Format DF - Downlink Format

In addition to the above, unsolicited responses (squitters) are emitted at a mean interval time of 1 second; the DABS Altitude response (DF4) is used. All of the ATCRBS functions have been preserved.

1.2 Basic System Modules

The baseline DABS transponder consists of the following modules:

- Front and Back Panel Interface
- System Clocking/Timing
- Pulse Decoding
- Arbiter Chip
- ATCRBS Reply Formatting
- Squitter Emission
- DABS Parity Check/Generation
- Stochastic Acquisition (Probability of Reply)
- Data Field Definitions
- DABS Reply Formatting
- All Call Lockout
- Comm A and Comm B

The modules are described in the following sections.

1.3 Back and Front Panel Interface

A data input connector is supplied on the back panel of the transponder. A jumper to ground on any pin results in that input being a "1". No jumper is understood as a "0". Therefore, no jumper connection results in a zero in the appropriate field which is interpreted as a "no capability" and "no discrete address".

There are thirty-nine inputs on the back panel. As shown in Figure E-1, twenty-four inputs are associated with the discrete address of the aircraft. Three inputs are associated with the capability of the aircraft. Three inputs are for the maximum airspeed input which is used in response to a BCAS interrogation. Another nine inputs, as shown in Figure E-2, are for the encoding altimeter; with none connected, the field is set to zero.

Figure E-3 illustrates the circuit for the front panel interface. The Function Selector Switch implements the same functions as those found on any ATCRBS transponder. The standby position applies power to all portions of the transponder. However, the ATCRBS logic is inhibited such that no responses are generated. The DABS logic is not inhibited, but rather reflects the "on-the-ground" condition in the flight status field. The Mode A (only) position enables the logic circuitry to respond to interrogations; if an interrogation requires an altitude report, then the altitude field is zero. This allows the pilot to inhibit the input from an encoding altimeter. The Mode A/Mode C position enables the full functions of the transponder, allowing the input of the altitude encoder. The test position turns all panel lamps on (e.g., ATCRBS, DABS, and IDENT).

The IDENT switch is a momentary contact pushbutton which triggers a 16-second timing circuit. Any ATCRBS interrogations within this time will produce a response containing a SPI pulse which will fill in beacon slashes on the air traffic controllers radar display. The SPI pulse will also cause the push-button to light.

Whenever a DABS or an ATCRBS response is made to a correctly received interrogation, an appropriate 16-second timer is triggered which enables a panel lamp. Whenever a DABS and/or ATCRBS panel light is on, the pilot has been alerted that a response has been made by the transponder at some point during the past 16 seconds. An automatic dimmer control is provided to adjust brightness.

The pilot may assign a four digit (4096) code to the aircraft through four switches on the front panel. This code is digitized into thirteen bits of information (which includes a "x" bit reserved for future use).

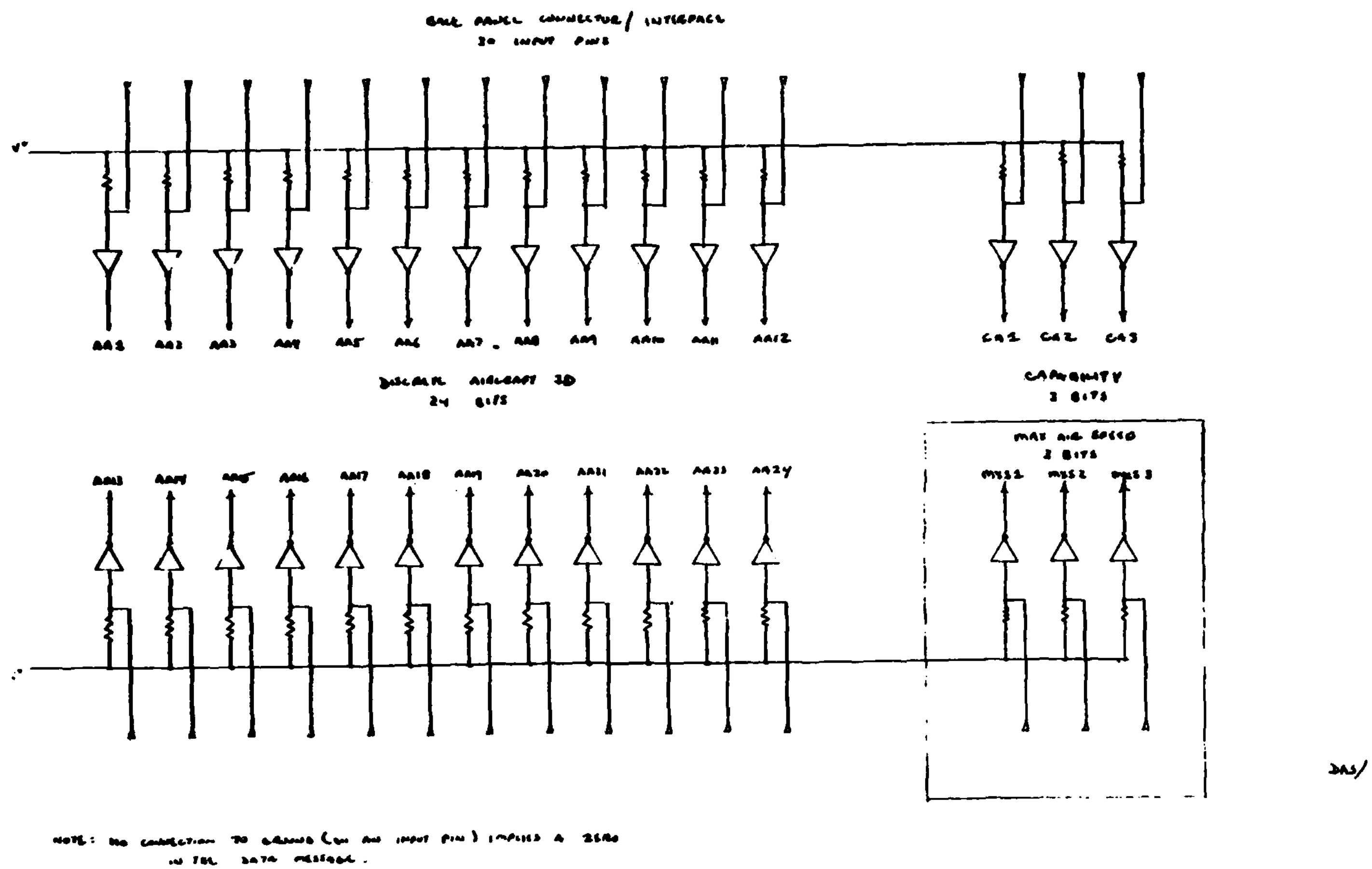


Figure E-1. BACK PANEL CONNECTOR/INTERFACE

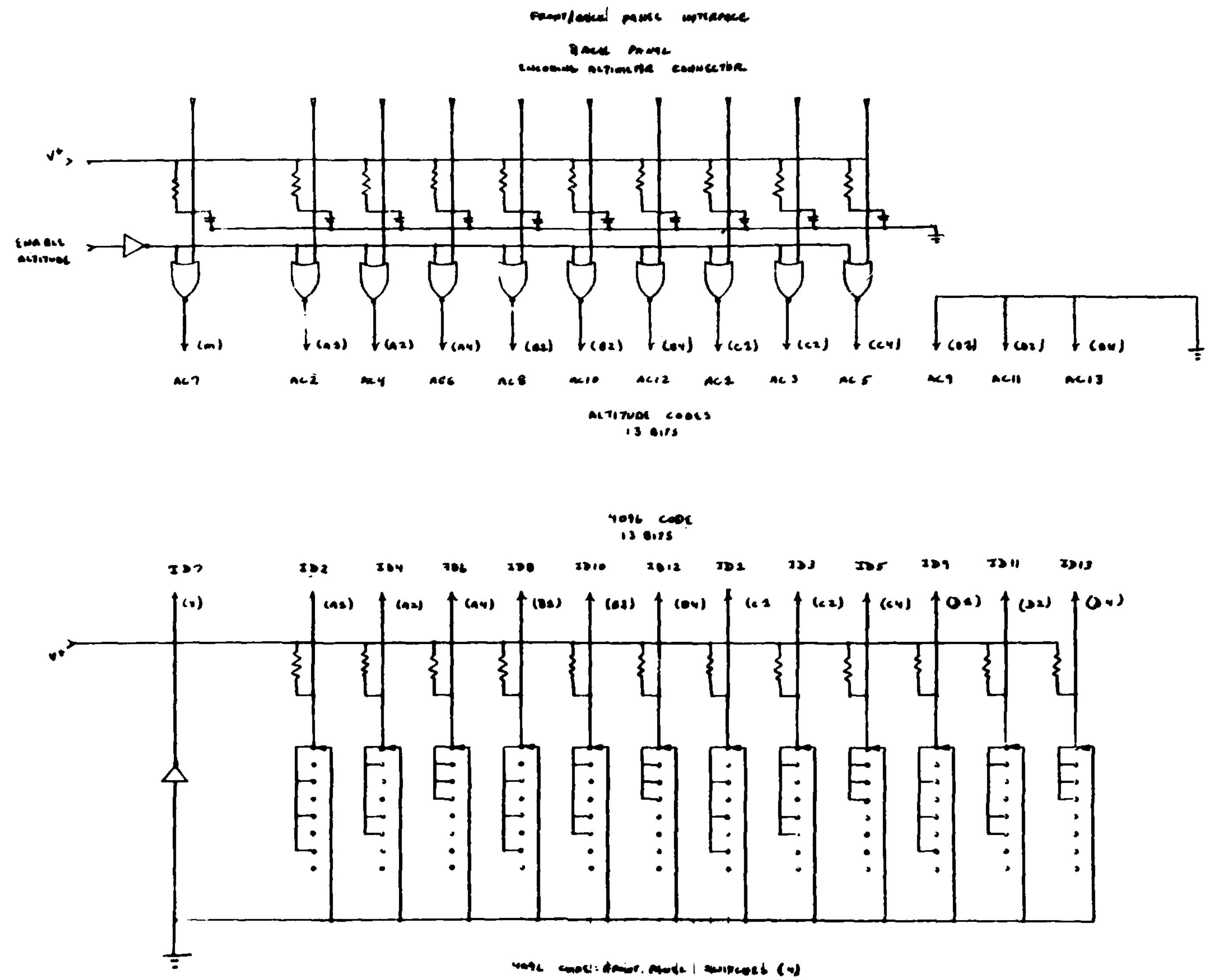


Figure E-2. BACK/FRONT PANEL INTERFACE

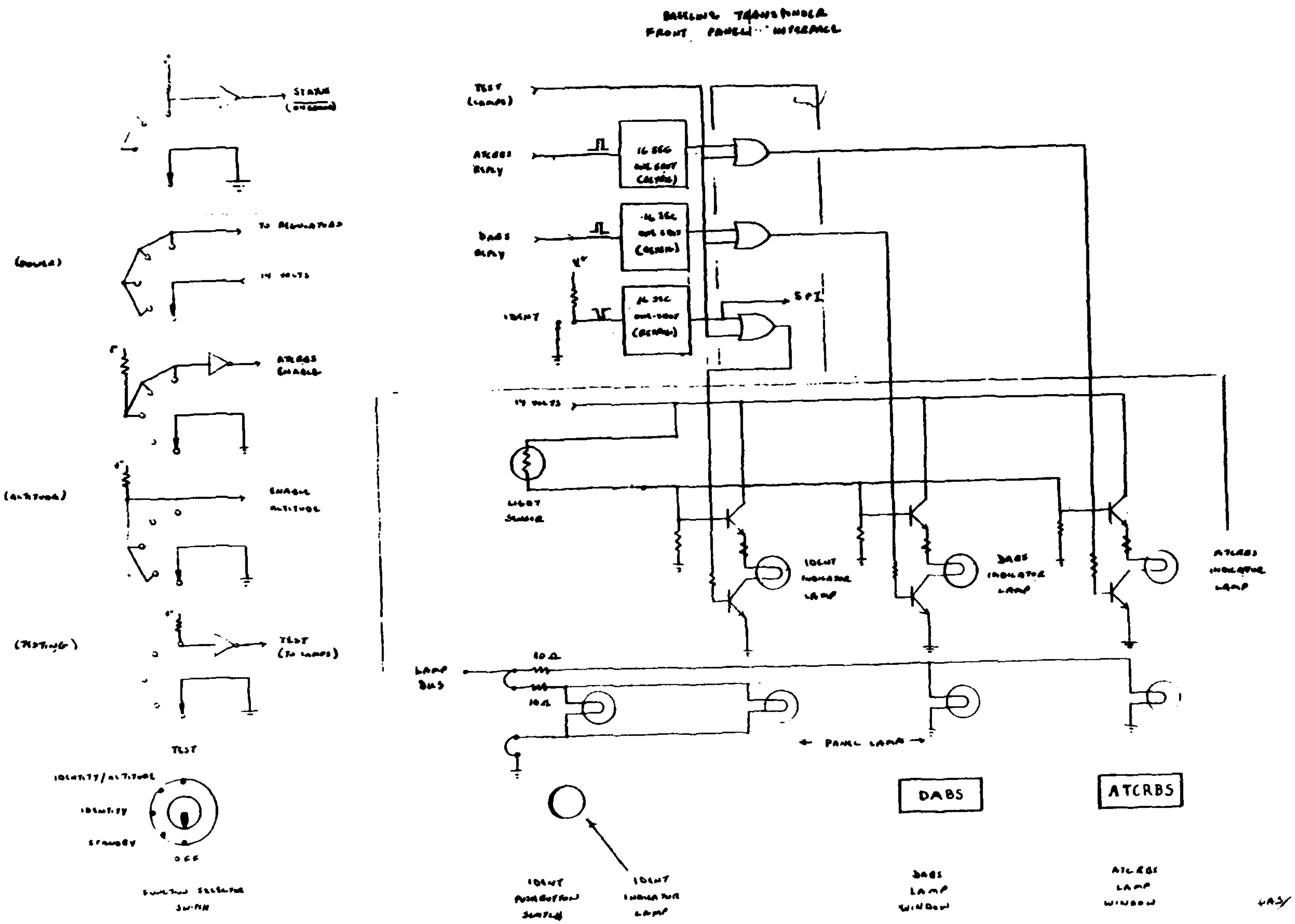


Figure E-3. FRONT PANEL INTERFACE

1.4 System Clocking/Timing

When power is applied to the transponder, a timing circuit produces a low level which sets all memory elements to zero (e.g., counters, flip flops, shift registers). The transition moves from a low to a high level 1 millisecond later and all circuits are then ready for operation (subject to the position of the Function Selector Switch).

A 24 MHz oscillator is ultilized to drive the digital logic into synchronization with the "P" pulse. This frequency was chosen so that one clock could be divided to supply the other clocks necessary for the logic, while at the same time avoiding possible harmonics which could interfere with the 60 MHz IF amplifier. A 20 MHz frequency would have been desireable because simple integer division would produce all of the clock frequencies necessary for the digital logic (i.e., division of 20 MHz by 5, 20, and 29 will produce frequencies of 4 MHz, 1 MHz and 689.7 KHz) however, harmonics of the 20 MHz frequency fall within the IF band.

The 24 MHz clock is divided by 6 to produce a 4 MHz clock and by 24 to produce a 1 MHz clock; these clocks control all DABS processing. The processing necessary to generate an ATCRBS response requires a 690 KHz clock (1.45 microsecond period). Dividing the 24 MHz by a constant number to obtain a fixed period between pulses will cause the cumulative error over the course of the ATCRBS transmission to exceed the $\pm$ 100 nanosecond tolerance for the starting edge of the last pulse (SPI pulse). The procedure we implemented involves generating a sequence of pulses separated by varying periods to compensate for the cumulative error. These periods are generated by dividing the 24 MHz clock by 35, 35, 35, 35, and 34. This pattern is repeated for the duration of the ATCRBS transmission, assuring that no pulse is generated which is more than 33.2 nanoseconds off the required spacing; this is well within the $\pm$ 100 nanosecond criterion.

Drawings of these circuits are not included in the appendix.

1.5 Pulse Decoding

Pulse Decoding implementation uses a counting technique to interpret the pulse combinations which are received. When a pulse (interpreted as a P1 pulse) arrives as Buffered Video input (that is, after it has been processed for amplitude and width criteria) as shown in Figure E-4, it triggers a binary counter. This counter provides an address to a Read-Only Memory (ROM) which then generates certain timing signals for further processing. Each counter value represents a certain time increment after the leading edge of the P1 pulse.

The Buffered Video Input is fed into shift registers operating at 24 MHz. The content of the registers is examined (by Pulse Detect B) to detect a P1 pulse, this occurance triggers a JK flip flop which enables a 10-bit binary counter. The ten output lines of the counter drive a ROM which generates additional timing signals. Whenever a pulse could occur, a timing signal is generated to detect its presence or absence. Spaces are checked at certain intervals to eliminate cases of false triggering. The pulse decoding timing diagram is shown in Figure E-5.

The various pulse combinations which are known to be valid, trigger flip flops which instruct subsequent logic to prepare a proper response. When an incorrect pulse combination is detected, a reset pulse is generated so that the control counter and all memory elements are prepared to receive the next incoming pulse. A reset pulse is also generated if an ATCRBS-only interrogation is received or if other DABS messages are received which the transponder is designed to ignore.

1.6 Arbiter Circuit

There are three types of transmissions which can be made by the transponder. An interrogation can produce an ATCRBS reply, a DABS reply, or an unsolicited reply (squitter) for BCAS purposes. A circuit has been included to decide which response will be made at a given moment. The Arbiter Circuit, shown in Figure E-6, utilizes a polling technique to select what type of processing should occur next. A free-running, two-bit binary counter (which drives a multiplexing unit) samples the three request lines. The first request for a transmission (i.e., the first sampled line which is high) sets a flip-flop;

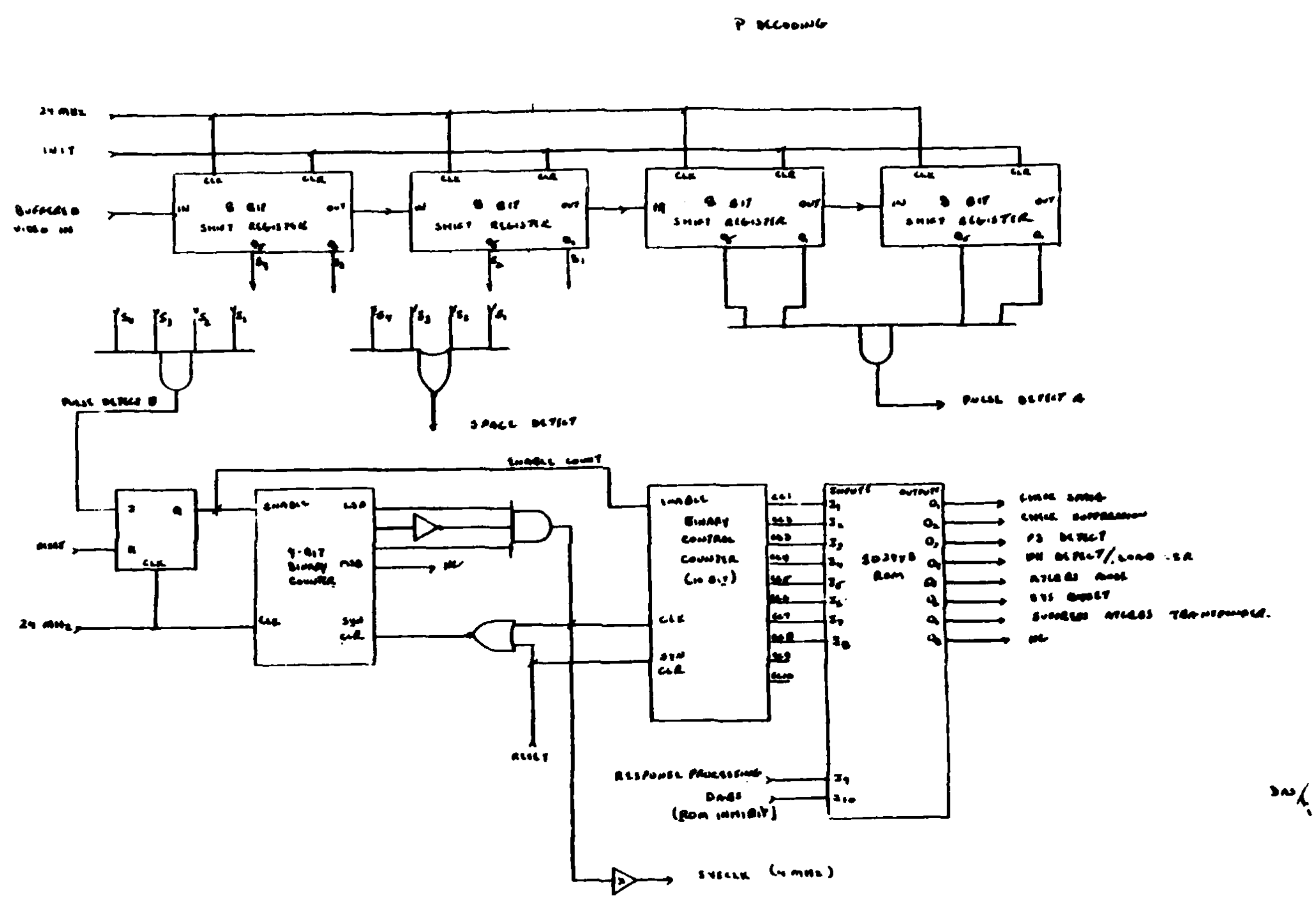


Figure E-4. PULSE DECODING LOGIC

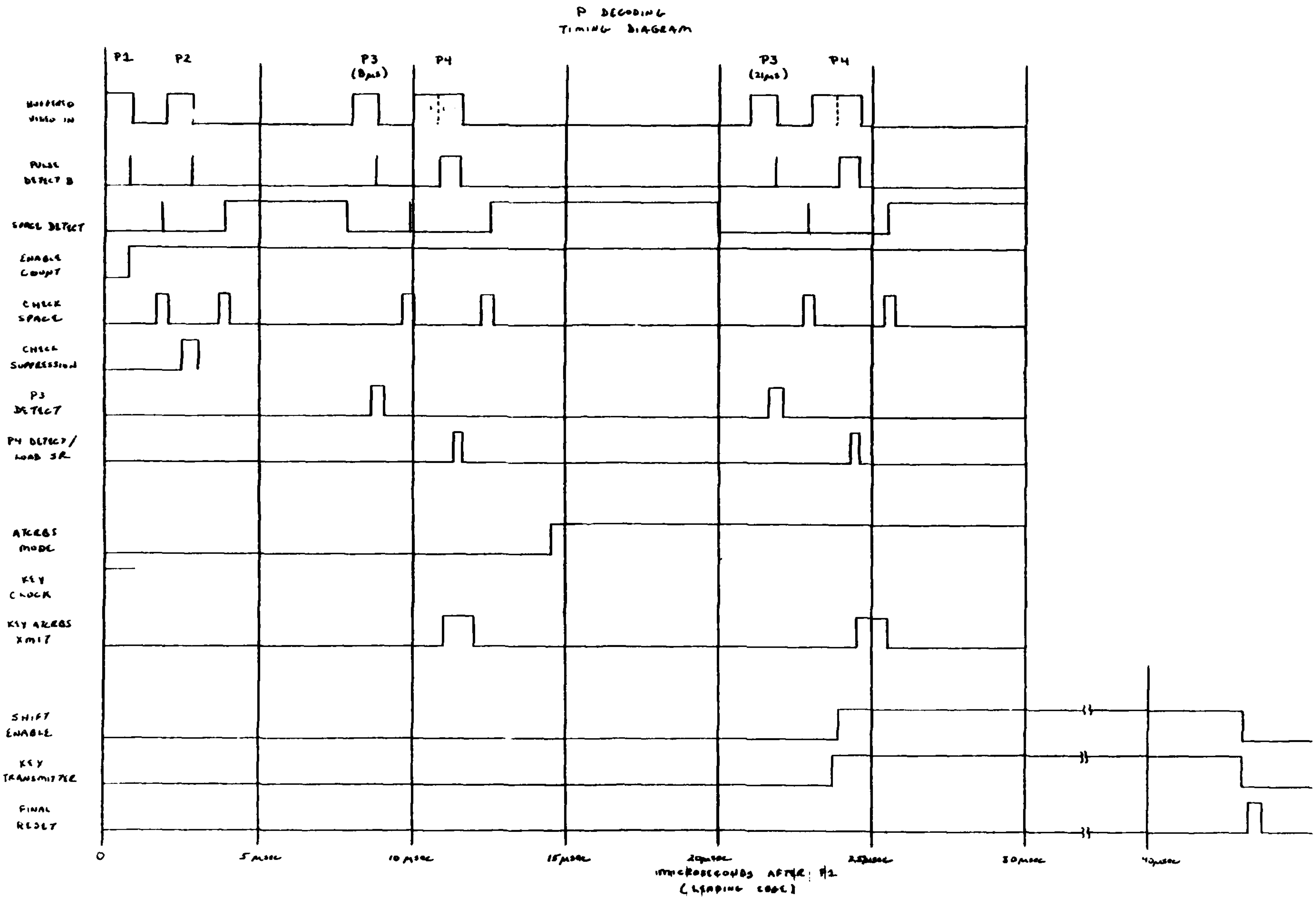


Figure E-5. PULSE DECODING TIMING DIAGRAM

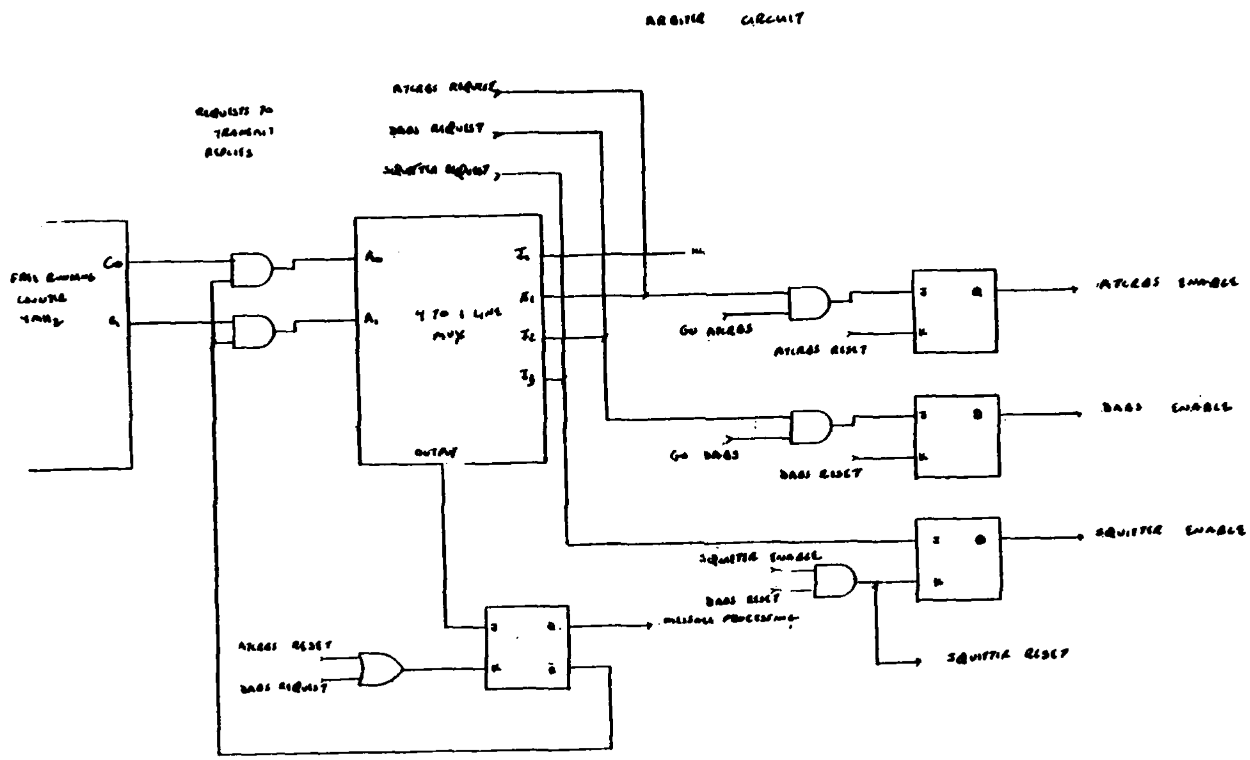
this indicates to other subsequent logic that a message is being processed and locks out the polling process until the message processing is complete (when the reset pulse occurs). The request for a transmission also sets a flip-flop at the time prompted by a control signal from the baseline transponder logic. For example, an ATCRBS request will set a flip-flop (which generates the ATCRBS Enable control signal to allow further processing) when activated by the GO ATCRBS signal from the baseline transponder control logic. This procedure is identical to that which is used with a DABS request. The squitter request process is slightly different in that it automatically sets a flip-flop to generate the Squitter Enable signal. In this case, when the DABS system is reset, the flip-flop is cleared along with resetting the squitter timing logic.

1.7 ATCRBS Reply Formatting

The main logic circuit determines the presence of a valid ATCRBS interrogation. If a suppression pulse (P2) is detected, then the circuitry is reset and the interrogation is ignored. However, if a valid interrogation is detected with no suppression, then a valid response is formulated. Figure E-7 illustrates the ATCRBS Reply control logic while the ATCRBS reply formatting is shown in Figure E-8.

A free-running oscillator at 2.76 MHz drives the circuit. When an ATCRBS enable pulse is detected, a counter is enabled; this counter drives a ROM which generates timing information. The counter divides the clock pulses by four, clocking all operations (except the ROM) at 690 KHz.

The ROM loads the shift register. The message is either formatted with ID information (mode A) or altitude information (mode C). If a P3 pulse is detected, the output of an encoding altimeter is loaded into a shift register. When ID information is required, it is entered via a set of switches on the front panel (the 4096 code). The SPI pulse can be activated to flash an indicator on the air traffic controller's radar screen. If the ground requests that the pilot squalk his identify, the pilot presses a panel button which loads the SPI pulses into the shift register upon the receipt of the next ATCRBS interrogation.



DAS/

Figure E-6. ARBITER CIRCUIT

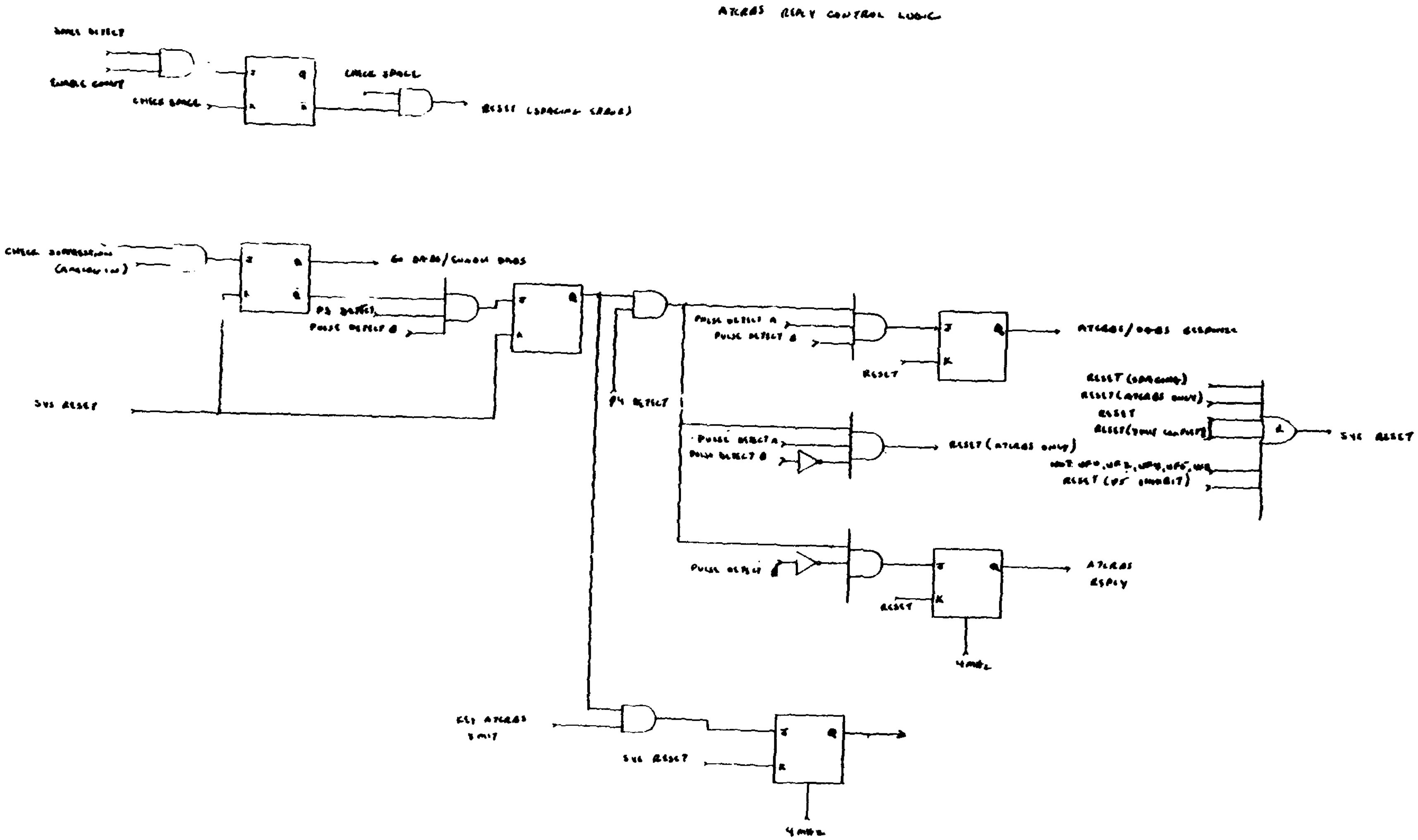


Figure E-7. ATCRBS REPLY CONTROL LOGIC

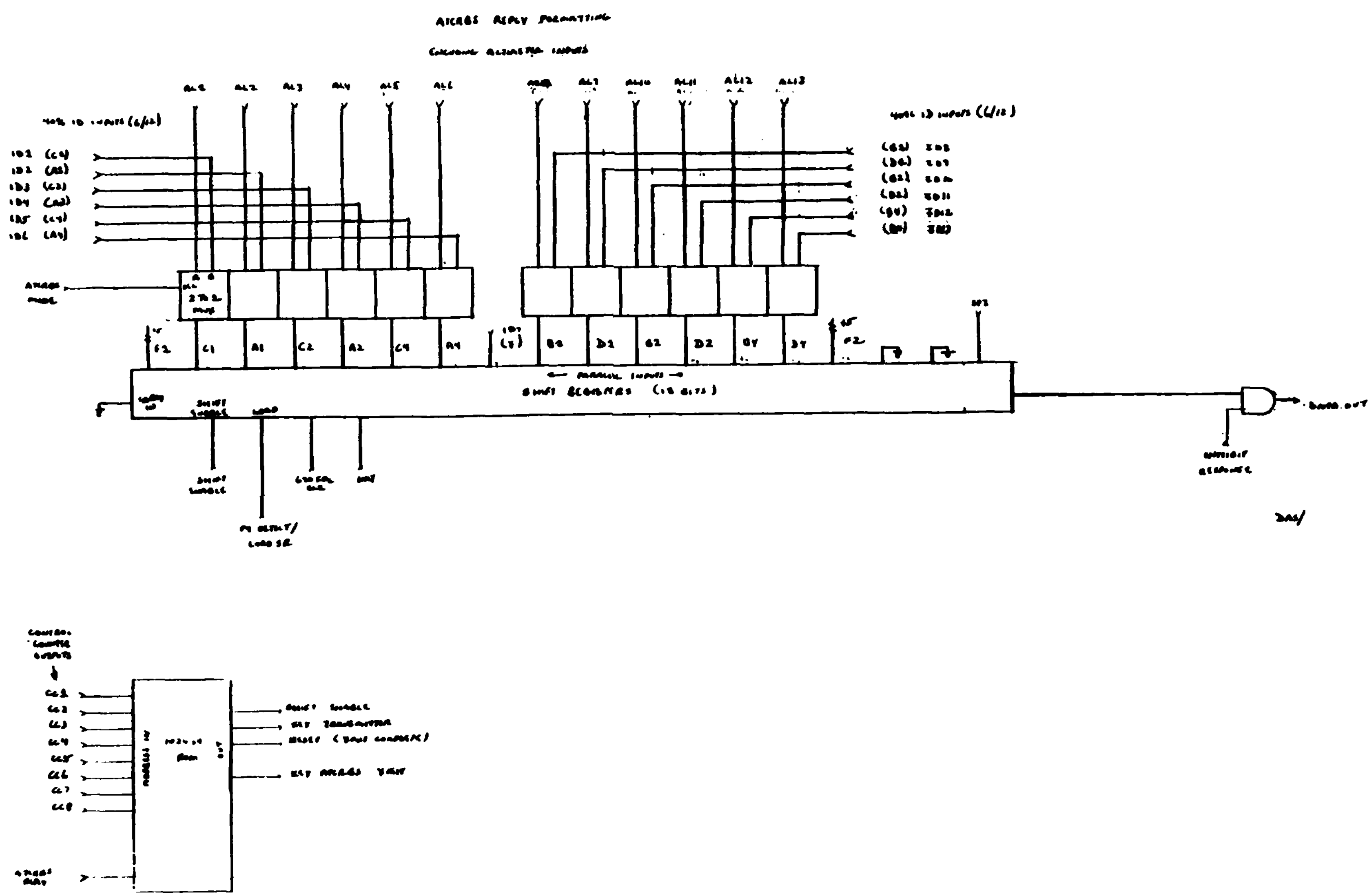


Figure E-8. ATCRBS REPLY FORMATTING

1.8 Squitter Emission

The squitter is an unoslicited reply. It is transmitted at an average of once per second for the benefit of BCAS surveillance by an airborne interrogator.

Squitters are emitted at random intervals with a mean value of one second and a standard deviation of 0.1 to 0.2 seconds. To accomplish the pseudo-random behavior of the events, a ROM is employed which contains a list of 256 intervals of time, which when executed in sequence, meet the criteria of the DABS standard. An eight-bit counter is utilized as the pointer in the list.

The interval of time specified by the eight bits is loaded into another counter which is then enabled such that it counts up to the maximum value. At this point, a carry takes place which sets a flip-flop, generating a request to transmit a squitter.

The squitter is sent unless it has been delayed due to the following controls:

1) an identical response (DF4) was sent within the past second

2) PC = 2 or PC = 3, indicating a lockout to squitters for the next 16 seconds

3) a message is already being formatted for transmission

4) mutual suppression (other equipment is being used)

Squitters immediately resume, following the interrupt condition. Each time the control logic cycles through a squitter transmission, it increments the counter which selects the next interval in the ROM and the timing begins again. Figure E-9 illustrates squitter generation.

1.9 DABS Parity Check/Generation

This logic, shown in Figure E-10, generates the Cyclic Redundancy Code used as the 24-bit parity code in DABS messages. This generated code is used to check the parity in uplink messages and to generate it for downlink messages sent by the transponder.

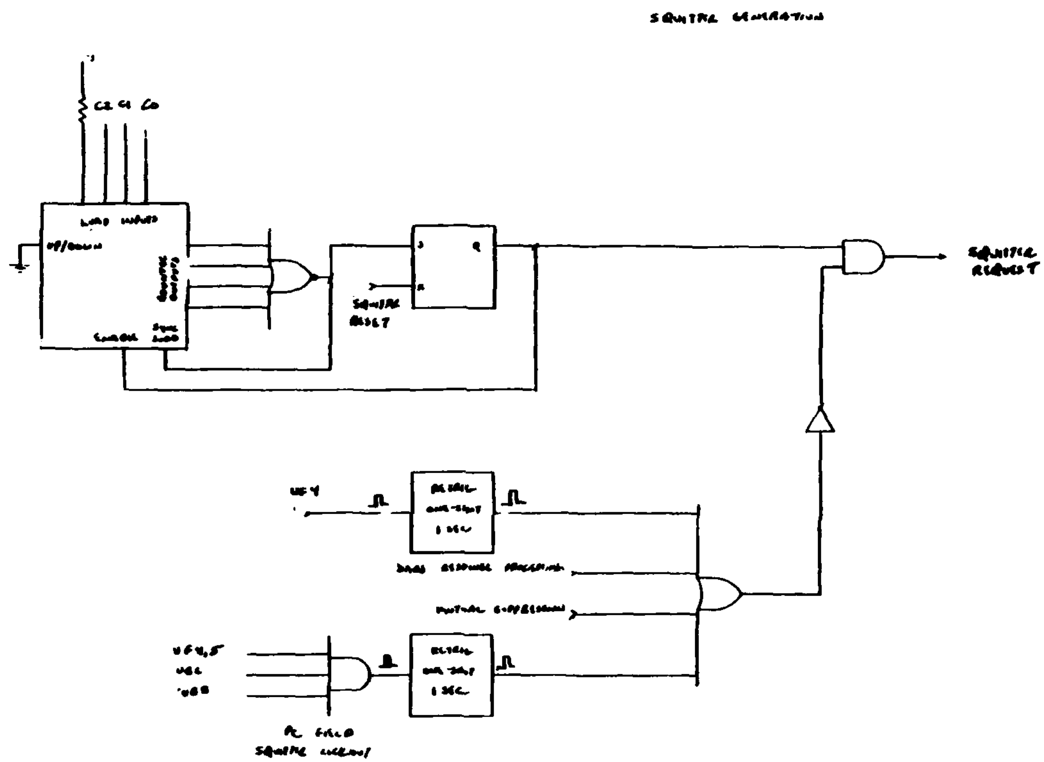


Figure E-9. SQUITTER GENERATION

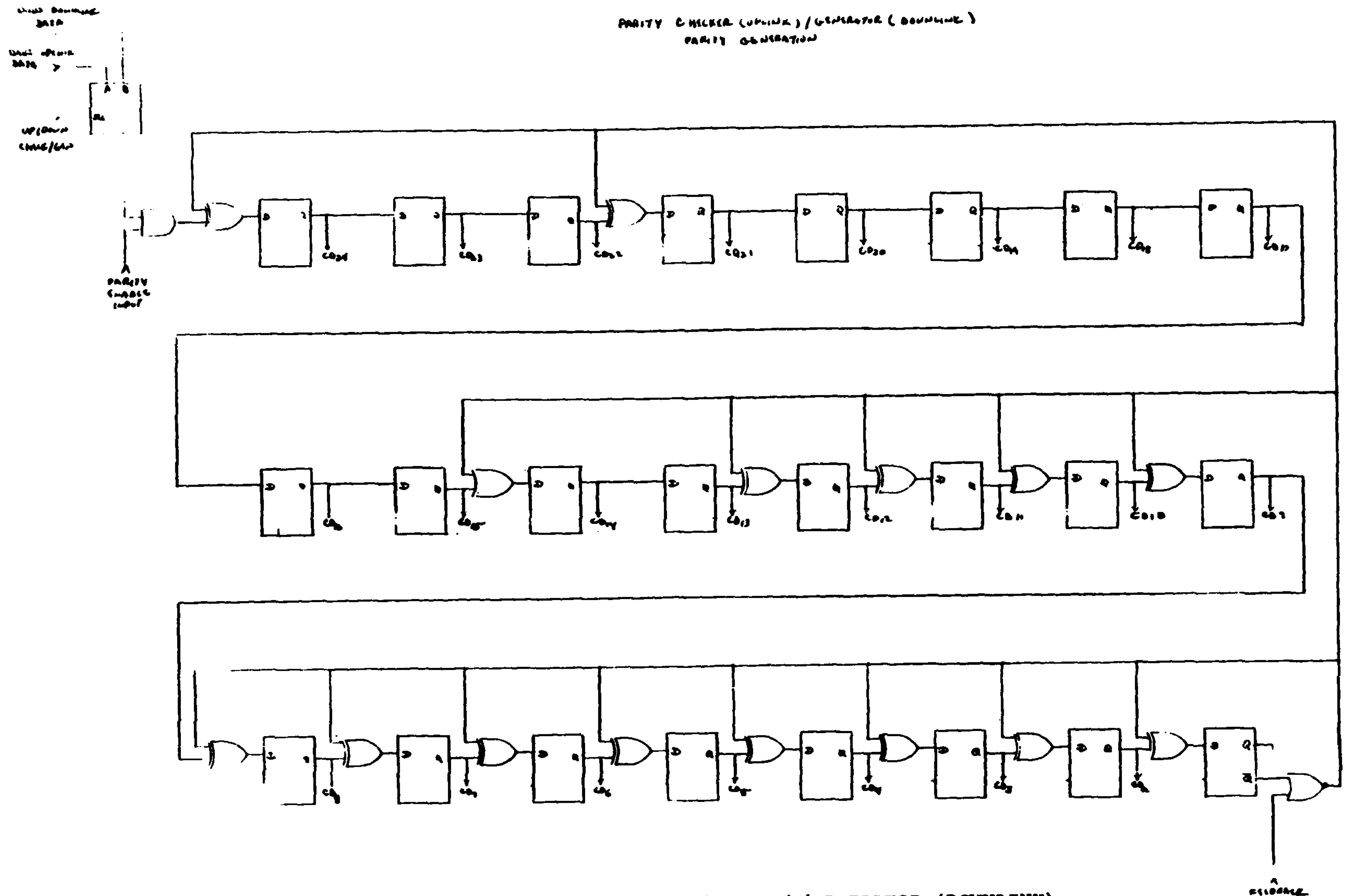


Figure E-10. PARITY CHECKER (UPLINK)/GENERATOR (DOWNLINK)

Thirty-two bits of data appear as serial input. Using the generator polynomial (as described in the DABS Standard, Section 4.1.1.1, page 25), a 24-bit remainder is created. This remainder (parity) is overlaid with further data.

In checking the parity on uplink messages, there are two cases to consider. If the uplink interrogation is UF11; a DABS-only All-Call, then no modification is made to the generated parity bits; a DABS-only All-Call contains no overlaid discrete address because it addresses all aircraft. Therefore, the generated parity bits are left untouched. If the uplink interrogation is other than an UF11, a DABS-only All-Call, the discrete 24-bit address associated with the aircraft is overlaid on the generated parity bits, module 2, on a bit-by-bit basis, as shown in Figure E-11.

In the case of a downlink message, the routine functions to generate the 24-parity bits based on the newly assembled 32-bit message. If the reply is to an uplink interrogation other than an All-Call, then the discrete 24-bit address is overlaid on the generated parity bits as before. If the reply is to a DABS All-Call interrogation, then the 4-bit II (Interrogator Identification) field found in the uplink interrogation is overlaid (added bit-by-bit, module 2) to the most significant bits of the generated parity bits. If the reply is to an ATCRBS/DABS All-Call, then, since no Interrogator Identifier is specified, it is overlaid onto the generated parity bits. However, since adding 24 bits of data which are all zeros, produces no change, the parity bits are left unmodified and processing is complete.

1.10 Stochastic Acquisition (Probability of Reply)

This logic utilizes a randomizing scheme to limit the replies of aircraft.

The probability of reply limiting takes place only when the appropriate code is transmitted during a DABS All-Call message (UF11), and replies according to the probability unless an All-Call lockout is in effect. When a DABS All-Call is received, the three least significant bits of the PR field (Uplink Bits UB6-8) determine the probability of reply. A free-running 4-bit counter has outputs which are decoded to produce four signal lines (D_0-D_3). During the course of a count cycle (0-15), D_0 is high one-

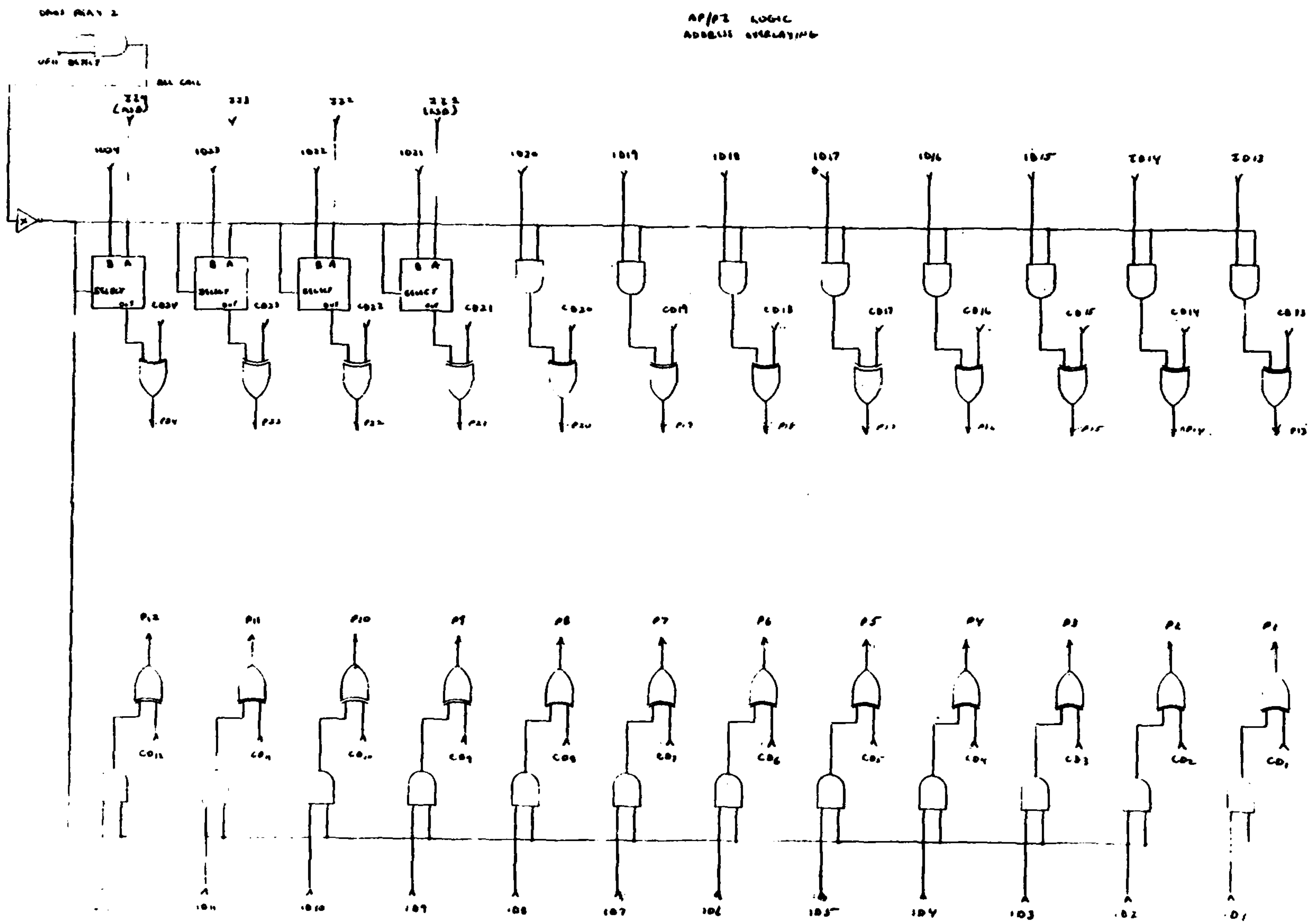


Figure E-11. AP OR PI FIELD ADDRESS OVERLAYING LOGIC

half the cycle, D_1 is high one-fourth the cycle, and D_2 and D_3 are high one eighth and one sixteenth of the cycle, respectively. The coding of the PR field selects one of five lines which determine whether a reply will be made. If PR = 0 or PR = 8, then a reply is made. If any of the other four lines is selected, it is added with the corresponding D line; if both lines are high, a reply is made. If not, the system is reset. The probability of reply logic for stochastic acquisition is shown in Figure E-12.

1.11 Data Field Definitions

The Alert data field logic triggers a 16-second timer whenever a change occurs in the 4096 code. On each clock pulse a 12-bit register stores the 4096 code. A 12-bit identity comparator compares the present 4096 code with the value stored in the register. If a difference is detected (e.g., when a change has been detected between clock pulses), then a pulse is sent to a 16-second one-shot circuit. The output entitled "Temp Alert" is fed to the circuitry which implements the flight status (FS) field. The "Alert" circuitry is shown in Figure E-13.

The FS data field logic illustrated in Figure E-14 sets a 3-bit code according to a prioritized list of conditions. If the circuit is airborne with no ALERT and no SPI the FS code is set to zero. FS equal to one is BCAS related and not part of the baseline system. With an ALERT condition, FS is set to two. If only the IDENT push button was pushed (SPI) the FS data field is set to four. The FS data field is set to six if both the ALERT condition is set (4096 code equals 7500, 7600, 7700 or other wise changed) and the pilot has pushed the IDENT push button within the last 16 seconds. If the circuit is on the ground with no ALERT and no SPI, FS is set to seven. FS equal to three or five are not assigned.

1.12 DABS Reply Formatting

The basic system must respond to five DABS message types: Short Special Surveillance (BCAS), Short Synchronous Surveillance, All-Call, Altitude, and Identity. This logic acts to select the proper data for incorporation into the downlink message. The first five bits are echoed from the interroga-

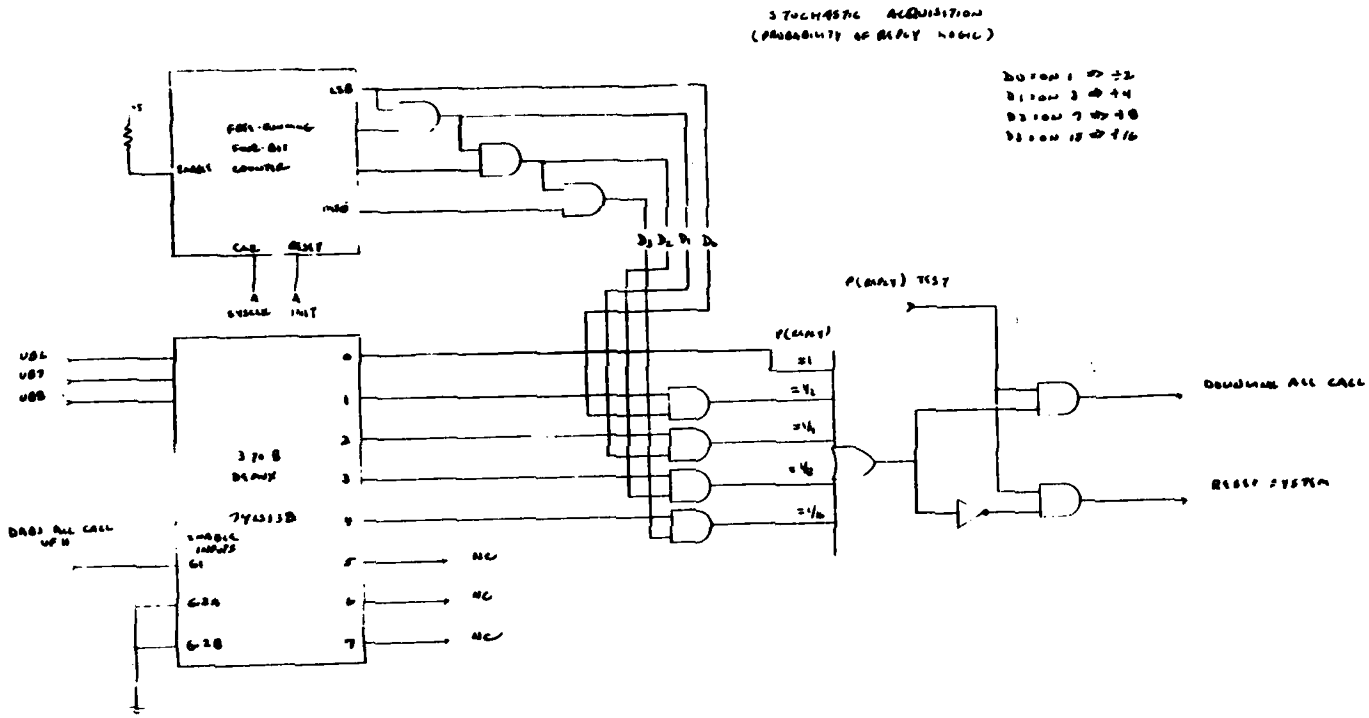


Figure E-12. *STOCHASTIC ACQUISITION*

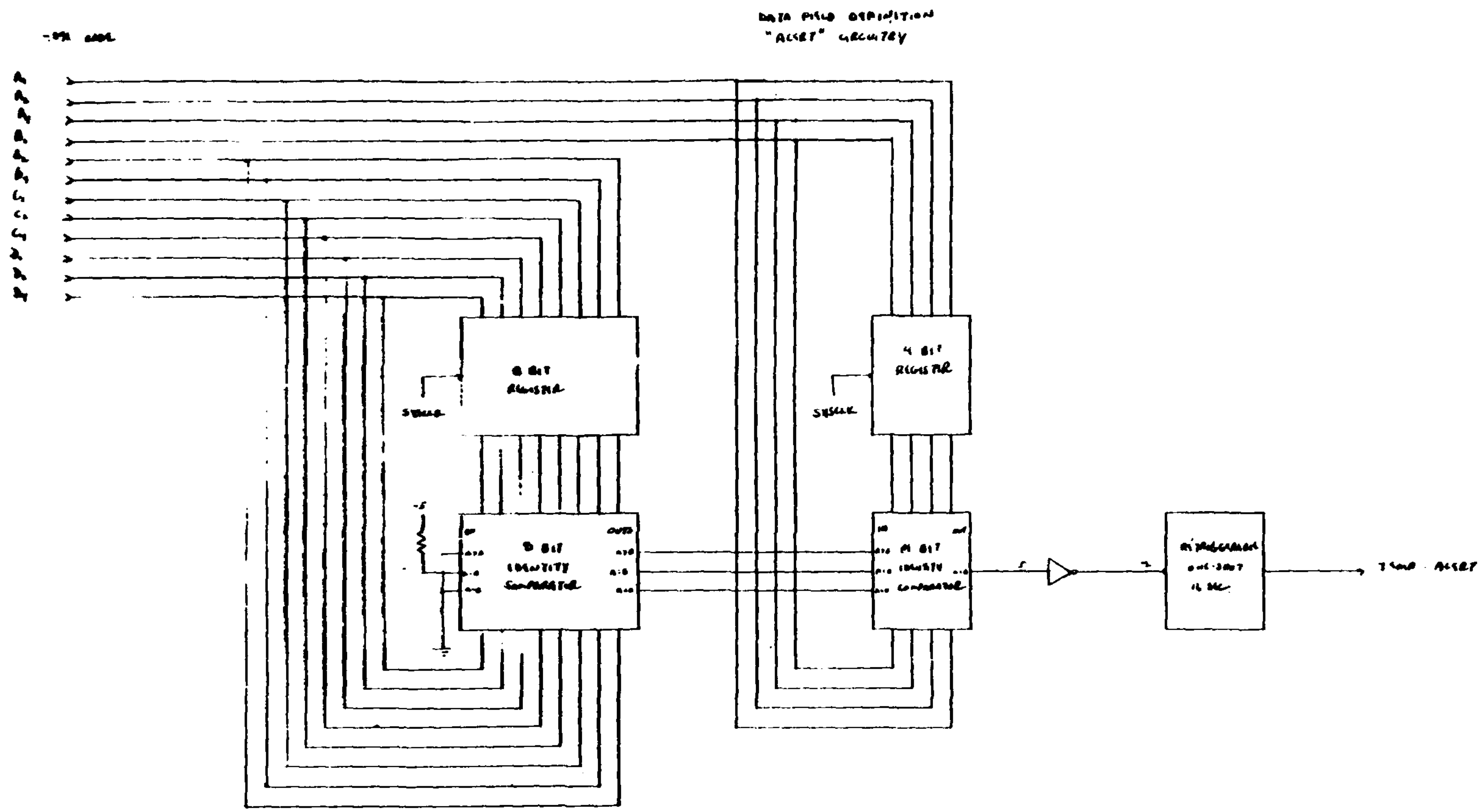


Figure E-13. DATA FIELD DEFINITION "ALERT" CIRCUITRY

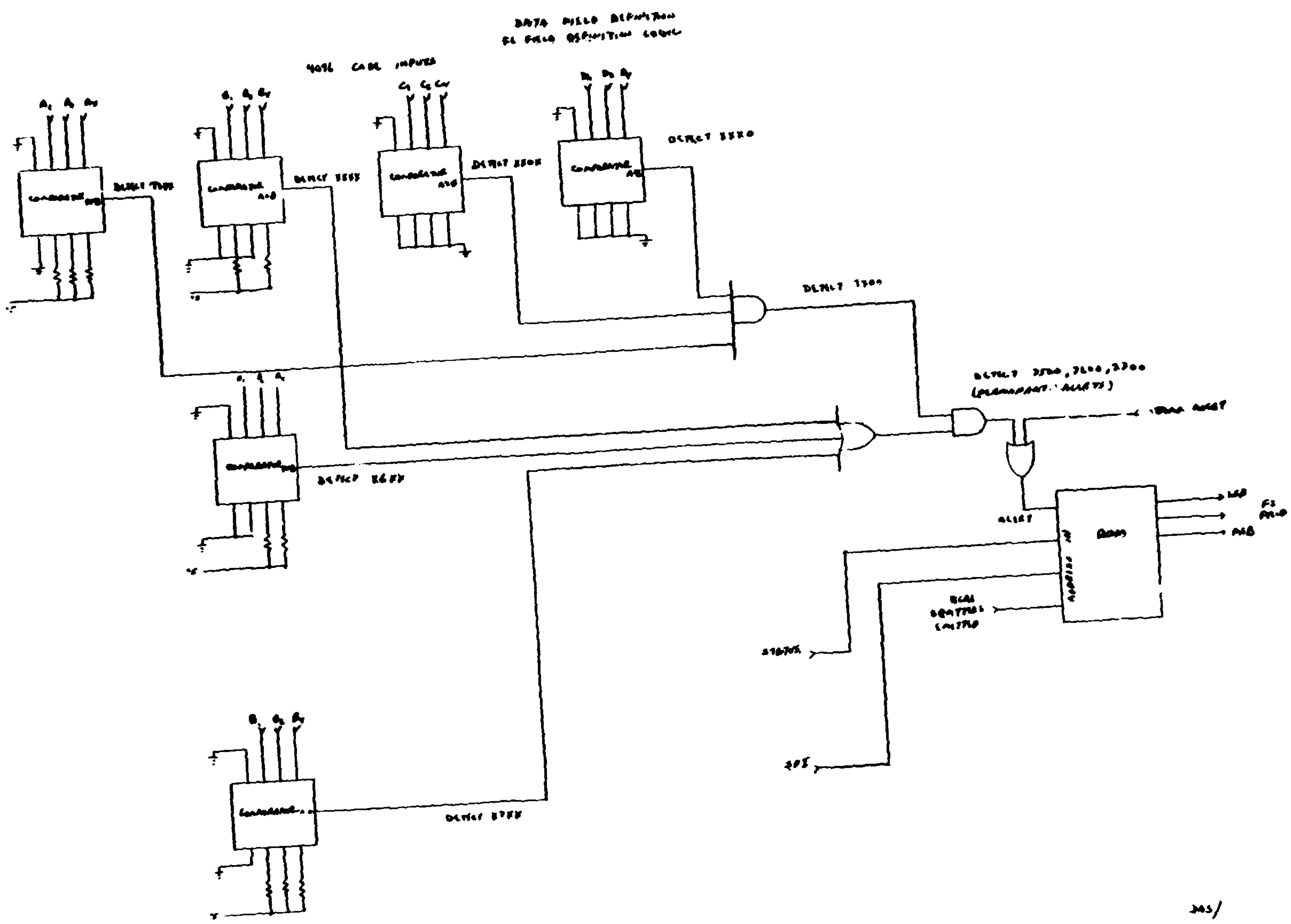


Figure E-14. DATA FIELD DEFINITION LOGIC

tion. These specify the format number. The next 27 bits are formatted by DABS reply logic. The remaining 24 bits are parity bits generated by other circuitry.

If the reply is a Short Special Surveillance Interrogation (UFO), then a reply is formatted echoing the Acquisition bit (Uplink Bit 6) from the interrogation, the maximum airspeed (3 bits from the back panel connector), and the aircraft altitude; all other data bits are zero. If the reply is to a Short Synchronous Surveillance Interrogation (UF2), then the 8-bit Epoch field is echoed in the reply with the aircraft altitude; all other data bits are zero. This design does not reflect the length of the Epoch field as defined in the current DABS National Standard.

If the reply is to an All-Call Interrogation, (UF11) then the logic selects two fields of data. The capability field (CA, 3 bits) is obtained from the back panel connector. The aircraft discrete address (AA, 24 bits) is also obtained from a back panel connector. This complete the 27 bit message.

If the reply is to an Altitude or Identify message (UF4 or UF5), then four data fields are selected. The flight status field (FS, 3 bits) is determined from additional logic not described here. The downlink request field (DR, 5 bits) and the utility message field (UM, 6 bits) are not utilized in this system and are set to zero. The fourth field is 13 bits in length and either aircraft altitude (AC obtained from the encoding altimeter) for an altitude interrogation (UF4) or aircraft ID (the 4096 code set by the pilot) for an ID interrogation (UF5). The DABS reply control logic is shown in Figure E-15, with the DABS reply formatting illustrated in Figure E-16 and E-17.

1.13 All-Call Lockout

The lockout circuitry shown in Figure 18 consists of three major sections: 1) the logic which sets the 15 timers which are associated with the 15 possible interrogators; 2) the logic which sets the standard All-Call Lockout timer; and 3) the logic which tests the conditions and generates an inhibit pulse (if necessary) to prevent a reply.

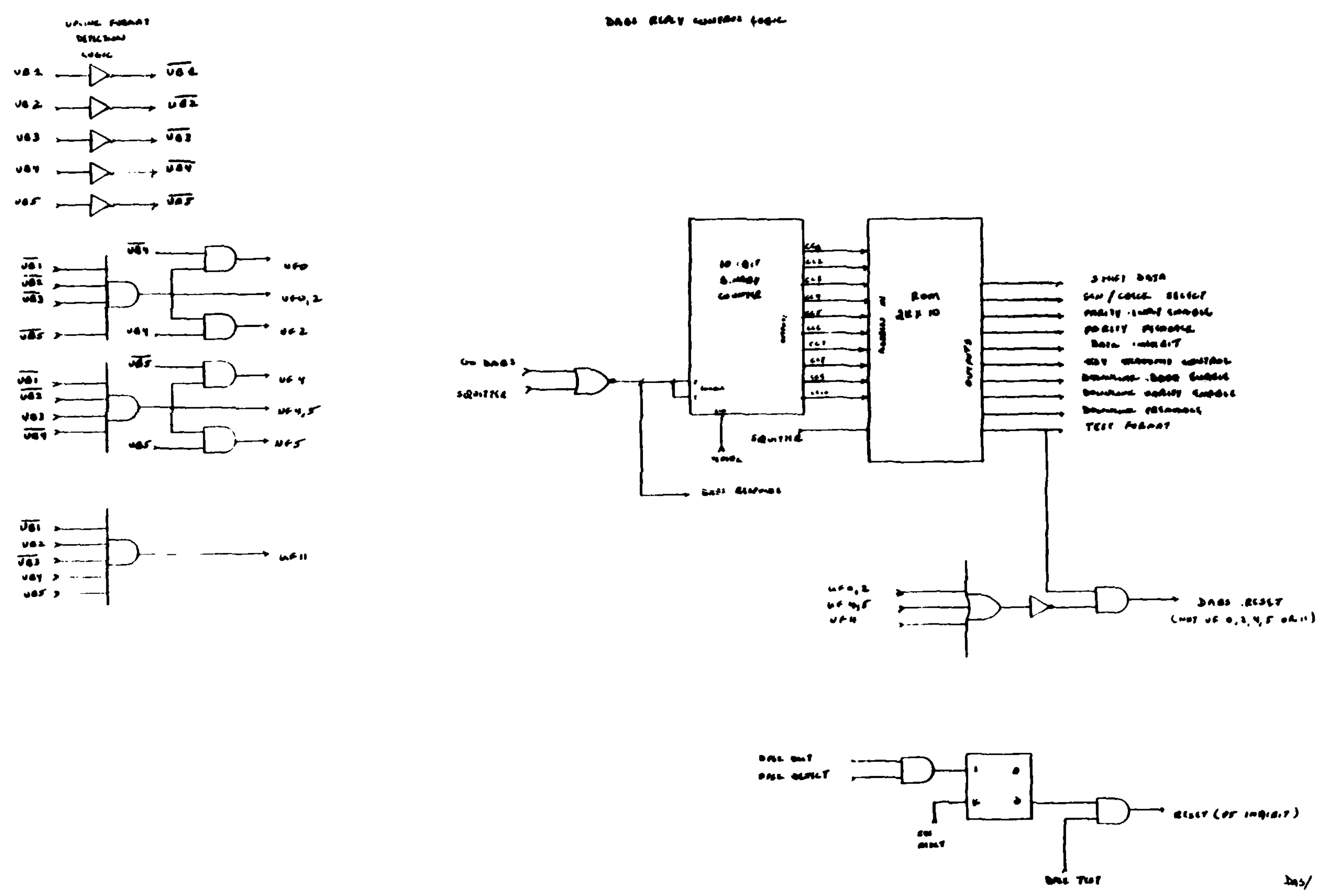


Figure E-15. DABS REPLY CONTROL LOGIC

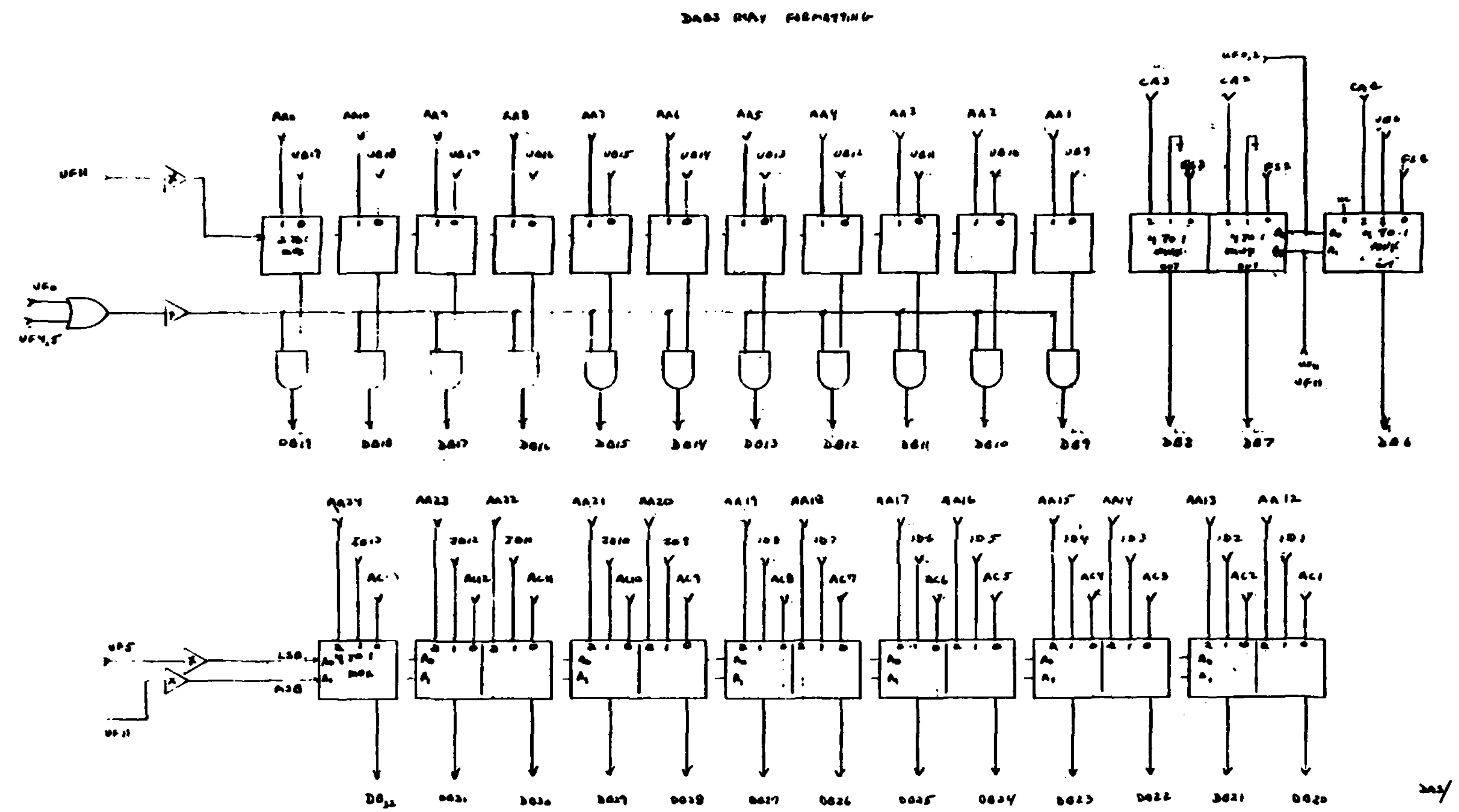


Figure E-16. DABS REPLY FORMATTING

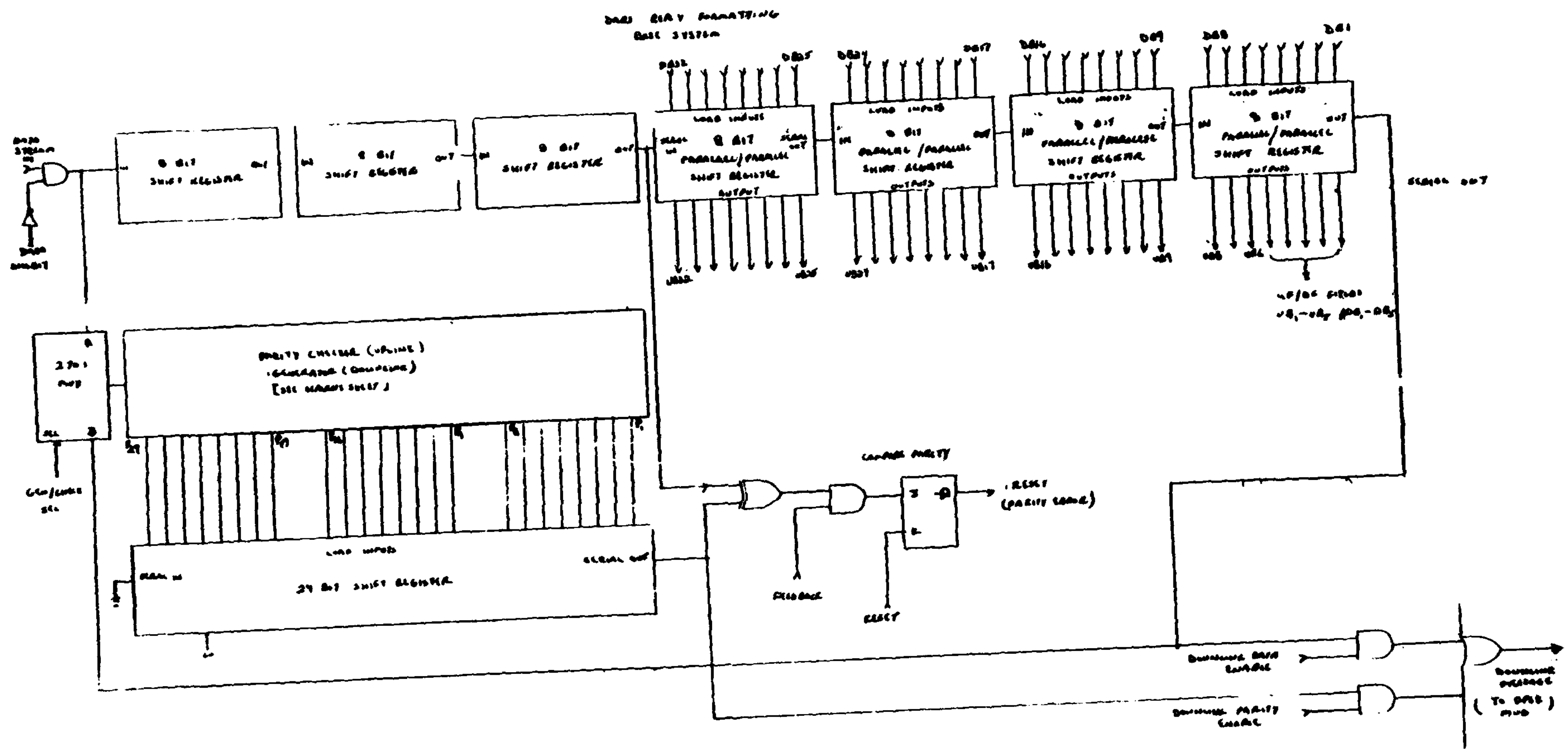


Figure E-17. DABS REPLY FORMATTING

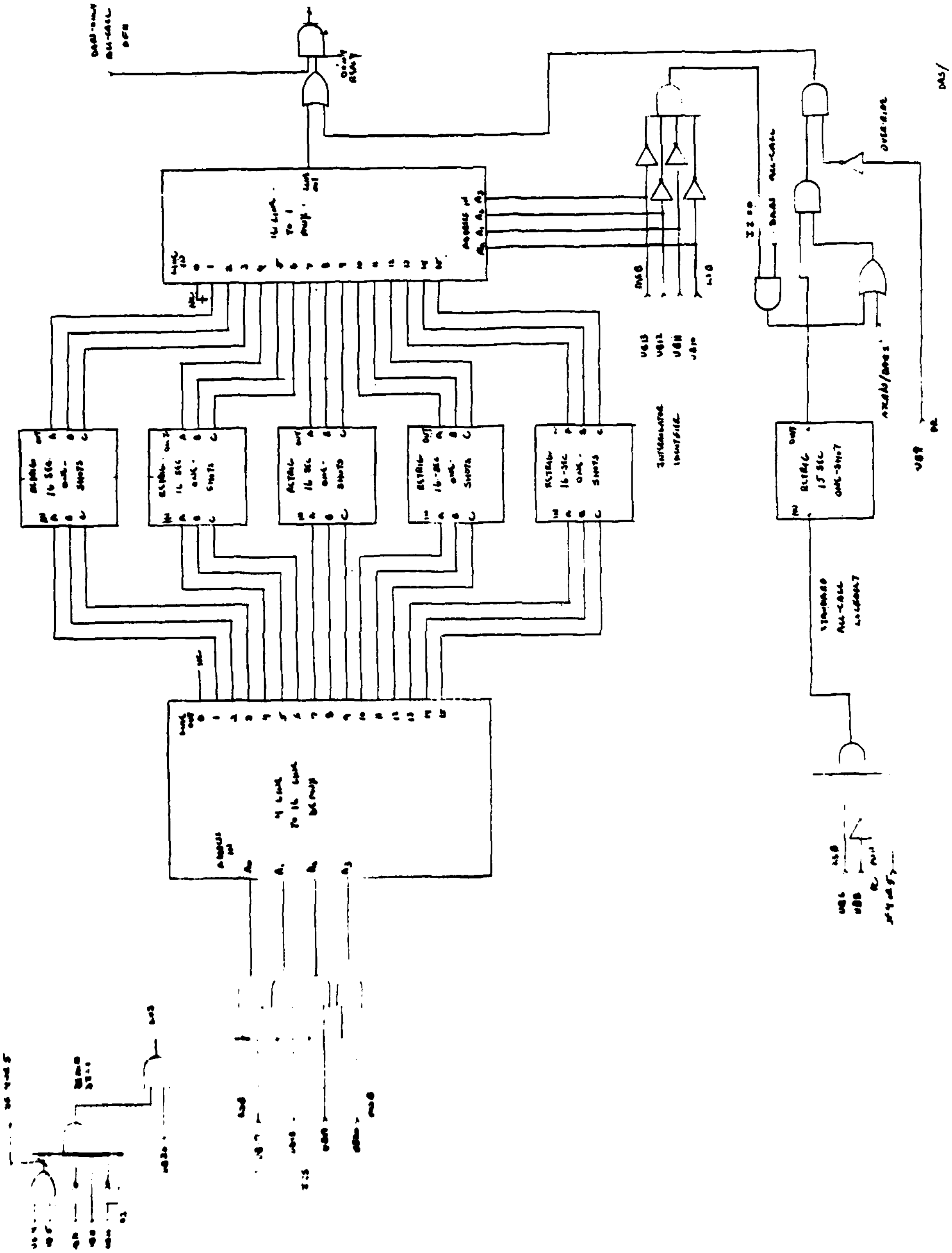


Figure E-18. LOCKOUT LOGIC

The timer setting logic operates as follows: in an uplink message 4 or 5 (UF4 or UF5), the condition of DI (UB14-16) indicates the contents of SD (UB17-32). Should DI equal one, then UB26, LOS contained in the SD field indicates the status of a restricted All-Call Lockout. If LOS equal one, the timer corresponding to the interrogator specified by UB17-20 (IIS) is set. IIS equal zero is a no-action operation. The timer which is triggered has a time-out value of 16 seconds unless retriggered. All 16 timers function independently.

The Standard All-Call Lockout timer can be set by the occurance of an uplink message 4 or 5 (UF4 or UF5), as well. If the message occurs and UB8 equal one and UB8 equal zero (corresponding to PC equal 1 or 3), then the 16-second Standard All-Call Lockout timer is set. It may also be retriggered.

The testing logic consists of two parts. The first tests the Restricted All-Call Lockout condition. If an All-Call is received with II not equal to zero, the timer designated by II is checked; if its output is high, a "Don't Reply" pulse is generated, inhibiting a reply. If II equal zero, then a "Don't Reply" pulse is generated, if D the standard All-Call Lockout timer is set and 2) the override signal (UB9 in the PC field) is zero. If the override signal is high, then no Standard All-Call "Don't Reply" pulse is generated. If the standard timer is set and an ATCRBS/DABS interrogation is encountered, a standard lockout condition will exist if no override is present.

1.14 Comm A and Comm B

The additional 56 bits of information transmitted from the ground in a Comm A interrogation are fed directly into a Random-Access Memory (RAM) from the baseline transponder control logic. This process is then supervised by local control logic which sends the 56 bits out of the transponder through a Standard Message Interface (SMI). The SMI consists of three ports: data out, data in, and bi-directional clock port. The local control logic writes the 56 bits received on the SMI into the RAM for later inclusion in the downlink response. This logic functions at the prompting of and in conjunction with the baseline transponder control logic.

The basic Comm A and Comm B logic is illustrated in Figure E-19. The baseline transponder logic and multisite protocol logic were modified as necessary to function with these added features; these modifications are not reflected in the drawing.

2.0 ATARS

2.1 Memory Enabling Logic

The 56 bits of ATARS data are shifted from the baseline transponder logic into seven eight-bit registers, as shown in Figure E-20. The first eight bits contain the Address Definition Subfield (ADS) which indicates the content of the remaining 48 data bits. These bits comprise two fields known as data sets; the ADS specifies the type of data sets which have been transmitted. A 74S138 demultiplexer is used to decode the bits to determine what the two data sets contain. For this implementation, aircraft own data sets and supplementary data sets are not utilized; therefore, messages represented by ADS 24 and 31 (with bit 48 set to zero) do not produce any action. The message represented by ADS 29 (start threat) is also not needed in this unsophisticated implementation.

Depending upon the message received, either or both uplink data sets may contain a position report which must be displayed. Memory elements (Latches) have been allocated to retain this data; 21 bits are assigned for the bottom display line (Data Set A) and 12 bits for the top display (Data Set B). Data loaded into Data Set A latches when a Start or End Encounter message (ADS 26), a Dual Proximity message (ADS 27) or a Threat message (ADS 30) is received. Data loaded into Data Set B latches when an Own Plus Positive message (ADS 25), a Dual Proximity message (ADS27) or a Single Proximity message (ADS 28) is received. The baseline transponder logic generates a Message Received pulse when the bits have been loaded into the shift registers in the proper position; this pulse enables the latches to copy and retain the uplink data. The message received pulse is also delayed by one clock period (1 microsecond) so that the 16-second non-retriggerable one-shot circuits can be activated. These circuits disable the latches so that a new message cannot replace the data from the last message until the 16-second time-out period has elapsed.

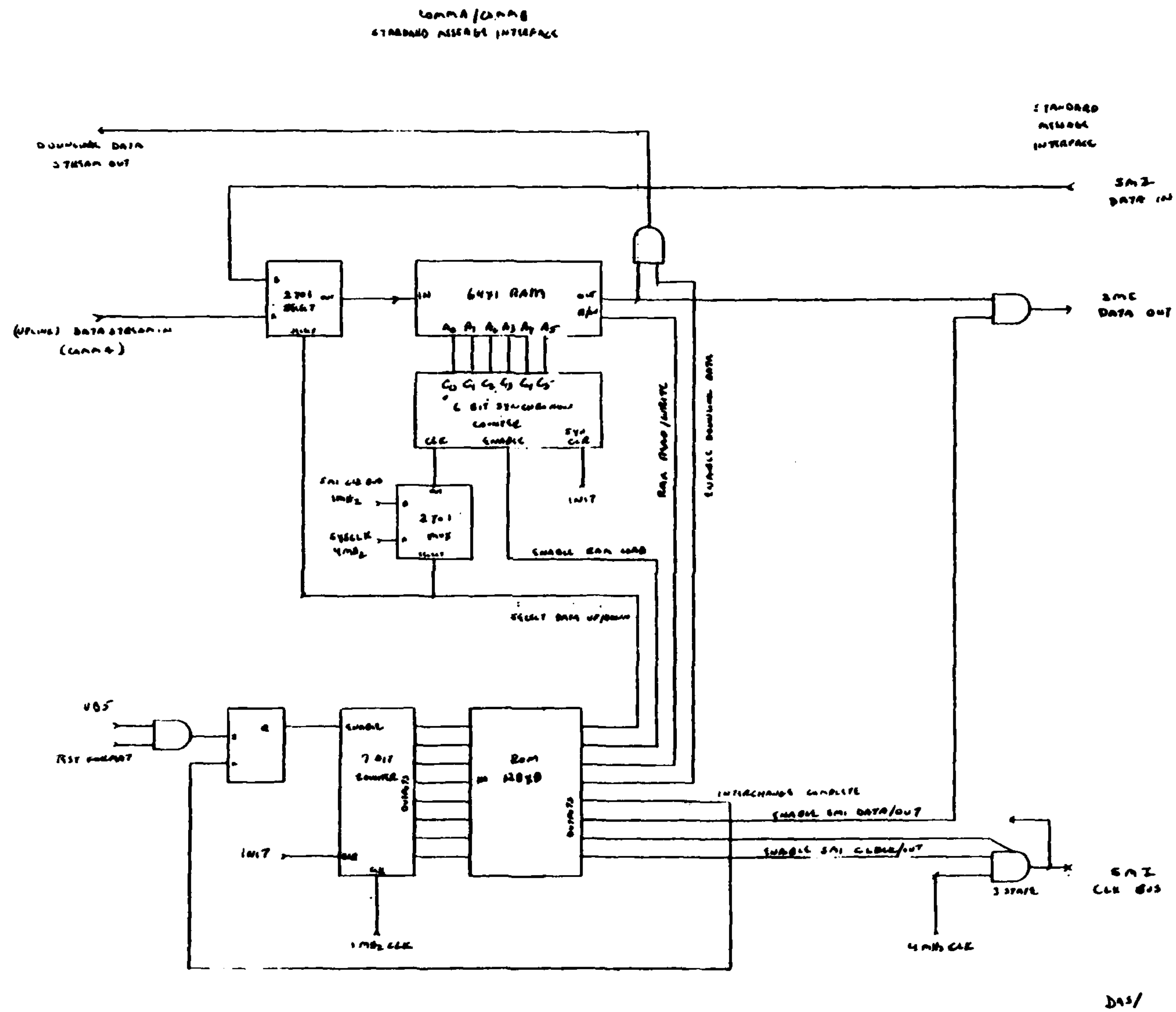


Figure E-19. COMM A/COMM B STANDARD MESSAGE INTERFACE

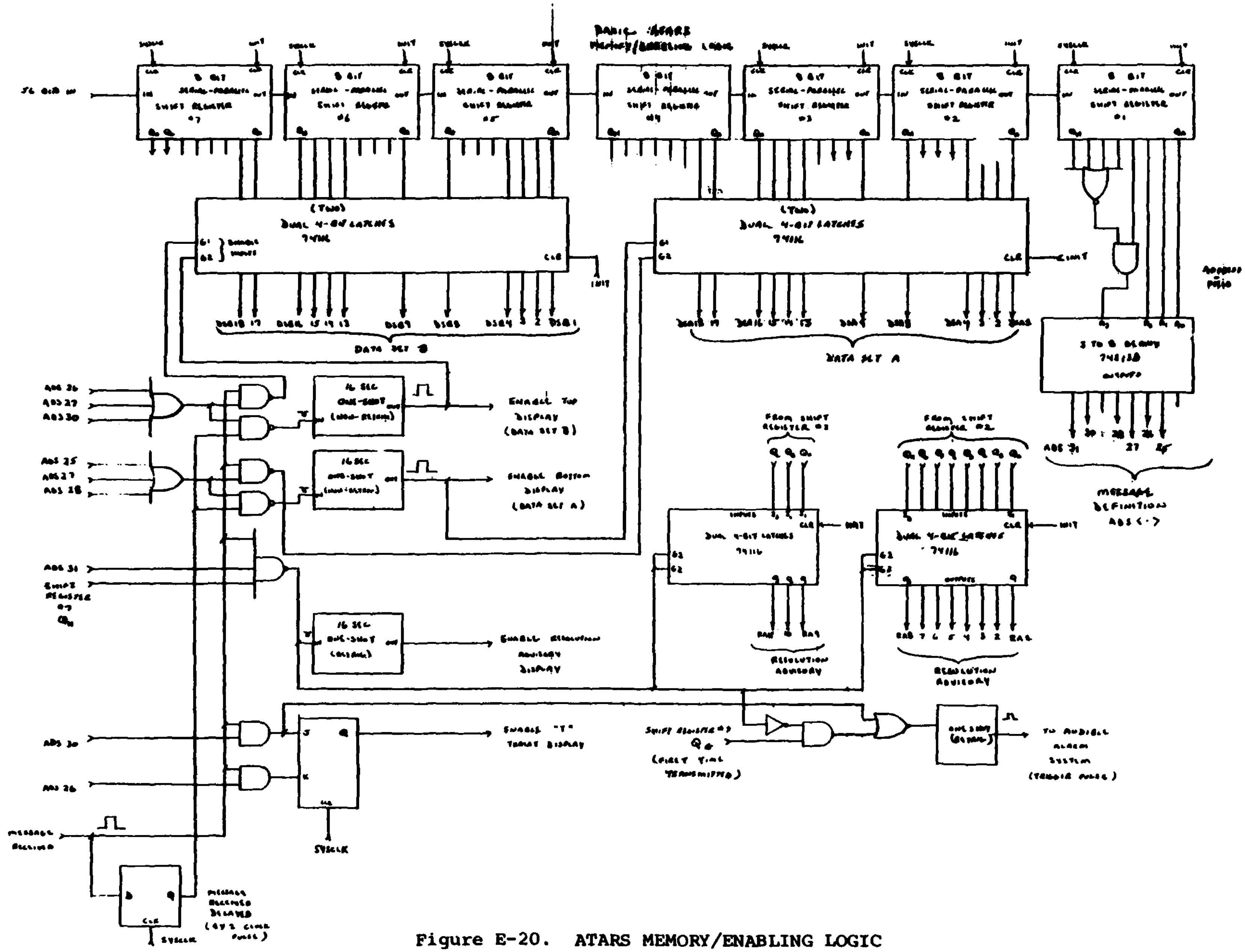


Figure E-20. ATARS MEMORY/ENABLING LOGIC

A third set of latches for Resolution Advisories retains the 11 bits of data used for decoding and display. When a Resolution Advisory message (ADS 31 coupled with bit 48 set to one) is received, the data is loaded immediately into the latches. This 16-second timer enables the display logic, but does not lockout the latches as in the case of Data Set A and Data Set B. This circuitry generates the control signals for the remaining logic. As previously mentioned, the timers enable the two Data Sets and Resolution displays. A red "T" is illuminated when a threat condition occurs. A flip-flop is set by a threat message (ADS 30) and cleared by a Start or End Encounter Message (ADS 26). Also an audible alarm (external to the transponder) is triggered when the first threat message (ADS 30) or a Resolution Advisory Message is received.

2.2 Advisory Display

When enabled, this logic, as illustrated in Figure E-21, decodes the eight bits corresponding to the eight possible advisories on this transponder (limit vertical commands were not used). These bits are decoded into signals which control the arrows and "X"s. Hex buffer chips (7417s) are utilized to drive the Light-Emitting Diodes (LEDs). An "X" is constructed using four LEDs; the arrows use three.

2.3 Bearing Display

The bearing display logic is illustrated in Figure E-22. The enable command (either Enable Button Display or Enable Top Display) controls the blanking input on the 7446A BCD-to-seven segment driver. Four bits of data are extracted to drive a ROM which creates a two-digit display indicating the clock bearing of the aircraft in proximity. The clock bearings that can be displayed are 1 through 12.

2.4 CO/HI/LO Display

The enable command for this display, illustrated in Figure E-23, allows the two altitude bits to be decoded into one of three messages: CO (co-altitude), HI (the proximate aircraft is above) and LO (the proximate aircraft is below). Seven-segment LEDs are used to display the characters. The 7417 drivers are implemented to drive the individual segments to spell the desired word.

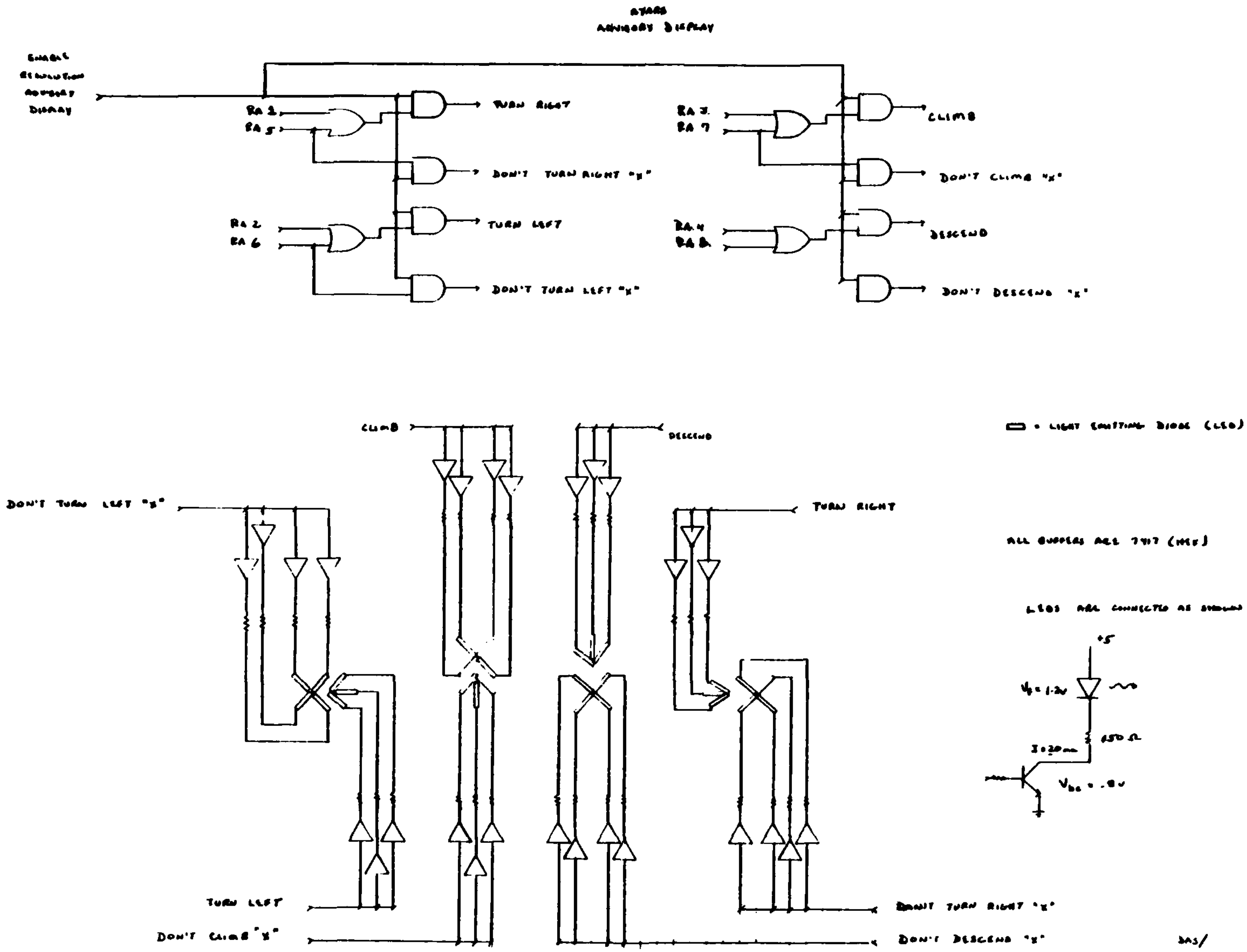


Figure E-21. ATARS ADVISORY DISPLAY

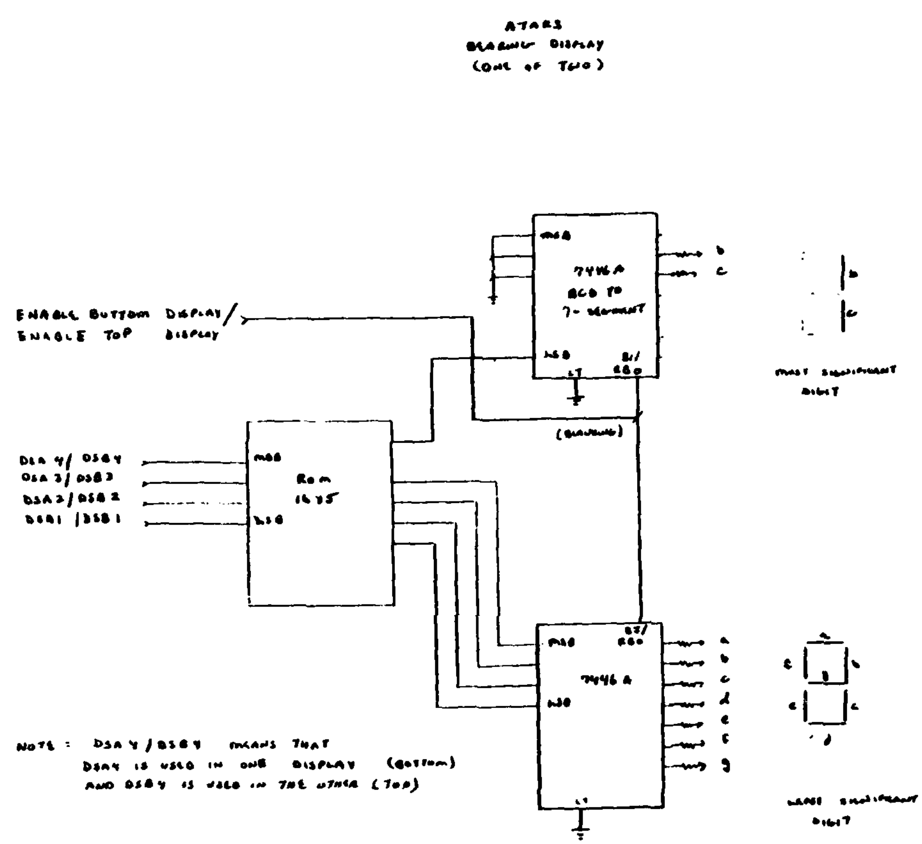


Figure E-22. ATARS BEARING DISPLAY (ONLY ONE SHOWN)

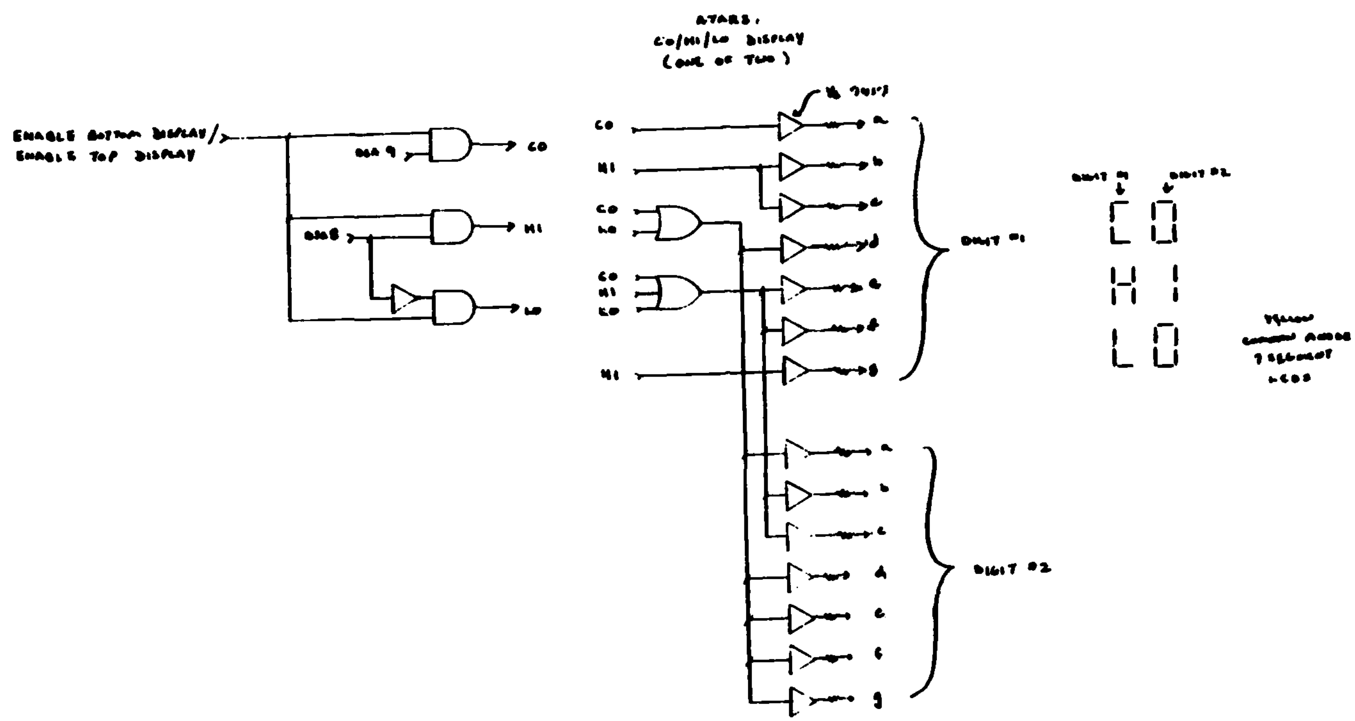


Figure E-23. ATARS ALTITUDE DISPLAY (ONLY ONE SHOWN)

2.5 Range Display

The enable command controls the 7446A drivers such that they display range in two digits (with decimal point in between). The six bits of range data are decoded by a ROM which provides eight bits of data to the drivers which control two 7-segment LEDs. The ATARS range display logic is shown in Figure E-24.

2.6 "T" Threat Display

When enabled, a "T" is displayed for a threatening aircraft. This "T" flashes at a 1Hz rate to indicate to the pilot that a proximate aircraft is a threat and that a Resolution Advisory could take place. An audible alarm is signaled by a one-shot circuit in conjunction with this display so that the pilot is alerted to this change in status of a proximate aircraft. Figure E-25 shows the logic circuit for the threat display.

2.7 BCAS Interface and Resolution Advisory Register (RAR)

The ATARS design also includes a RAR capability and an interface to an on-board BCAS unit. Upon receipt of each ATARS uplink message, the eleven resolution advisory bits are stored in latches as well as in shift registers. The latches drive the ATARS display. As shown in Figure E-26 the on-board BCAS unit may request the eleven bits from the shift registers by generating a load signal (LOAD RAR DATA) and supplying the clock pulses (BCAS CLOCK). This request procedure, however, may be interrupted by an uplink message. Whenever an uplink message is received, it is given priority, since the data cannot be repeated without retransmission. Should the registers be loaded with new resolution advisory data from an uplink message while the previous data was being shifted to the BCAS unit, the BCAS unit is notified by the receipt of an UPLINK BCAS MESSAGE RECEIVED signal and BCAS reinitiates the procedure.

BCAS may modify the resolution advisory bits driving the display by taking advantage of the structure of the ATARS message decoding logic. BCAS generates a 56 bit message (BCAS DATA OUTPUT) which is directed into the seven ATARS shift registers through the 56 BITS IN port. When all data is in the proper location, then BCAS generates a pulse (RAR MESSAGE SEND) to the ATARS logic (as a MESSAGE RECEIVED pulse) which loads all of

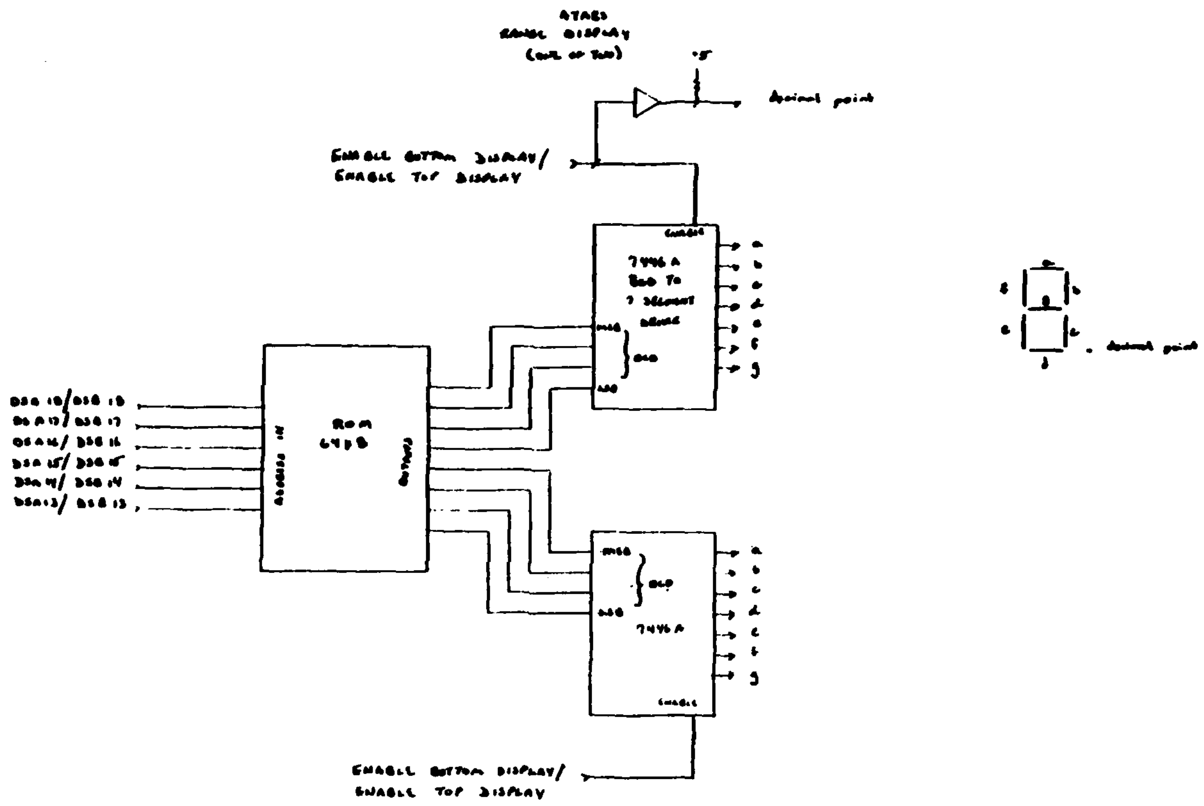


Figure E-24. ATARS RANGE DISPLAY (ONLY ONE SHOWN)

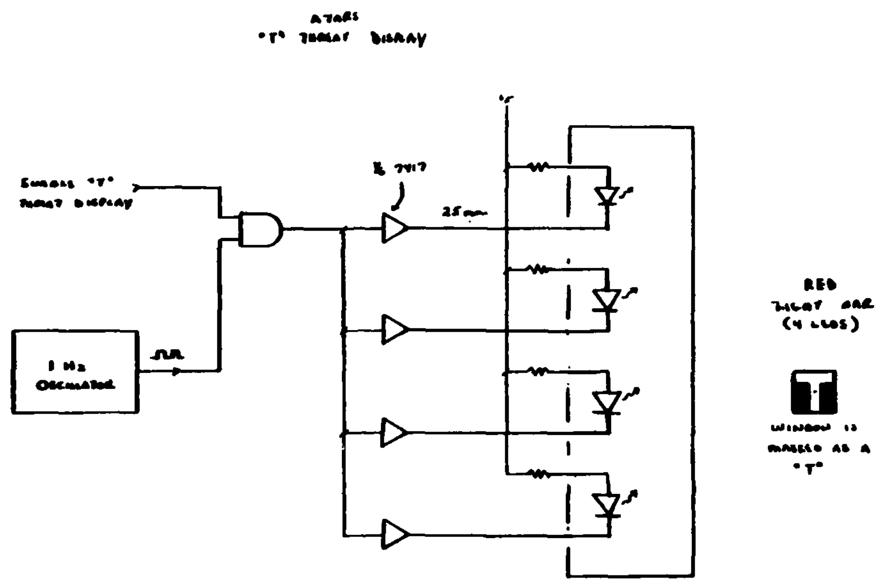


Figure E-25. ATARS "T" THREAT DISPLAY (ONLY ONE SHOWN)

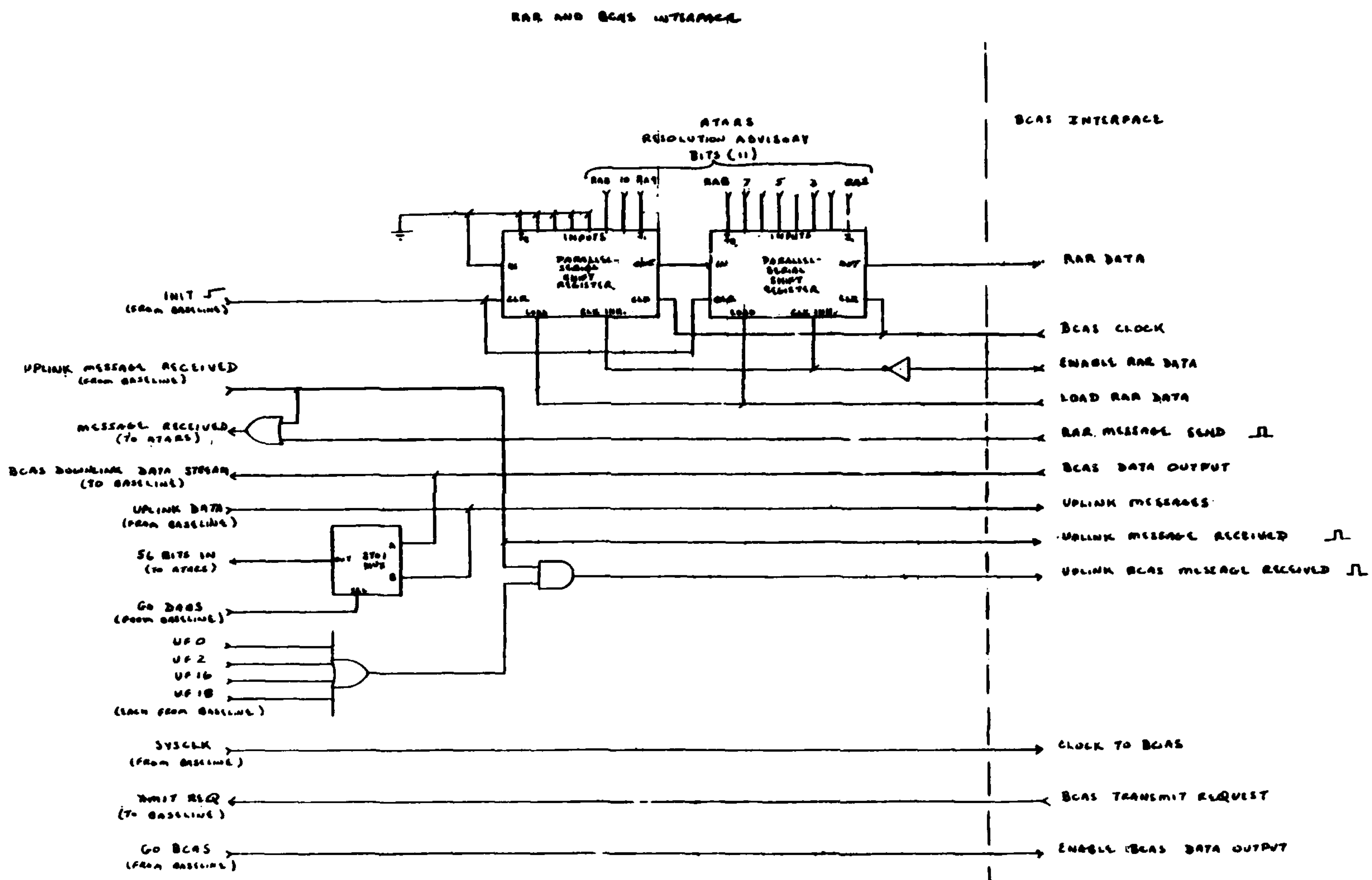


Figure E-26. RAR AND BCAS INTERFACE

DAS/

the resolution advisory bits in the appropriate registers in the same manner as the receipt of an uplink message. This procedure may also be interrupted by an uplink message. Should the ATARS shift registers be receiving BCAS data when an uplink message occurs, the BCAS unit is notified by the receipt of an UPLINK BCAS MESSAGE RECEIVED signal as before and BCAS may also reinitiate this procedure at some later time.

For the on-board BCAS unit to generate an air-to-air interrogation utilizing the DABS transponder, a request is sent (BCAS TRANSMIT REQUEST) to the baseline transponder logic which responds to BCAS with a confirmation of the start of the transmission sequence (ENABLE BCAS DATA OUTPUT). The contents of the message from BCAS are then shifted out (according to the transponder system clock) for inclusion in the downlink data message initially formatted by the baseline transponder logic.

All uplink messages received by the DABS transponder which have been correctly addressed and properly decoded are sent to BCAS (UPLINK MESSAGES). A pulse (UPLINK MESSAGE RECEIVED) indicates the arrival of each message for timing purposes. The receipt of uplink messages containing BCAS data are also indicated by a pulse (UPLINK BCAS MESSAGE RECEIVED).

3.0 EXTENDED LENGTH MESSAGES (ELM)

3.1 ELM (Uplink Only)

The central component in this design, as illustrated in Figure E-27, is an 8048 microcomputer which acts as the process controller. It interfaces to the baseline transponder logic and provides the liaison with the 2Kx1 Random Access Memory (RAM) (used for storage of the ELM segments) and the External Data Device (EDD) which buffers the segments to the data terminal. The microcomputer performs both housekeeping functions and functions necessary for the proper receipt of the ELM segments.

While the microcomputer cannot process data at a 4-megabit/second rate, it can act as a controller for a RAM which can handle the data rate. When the microcomputer is advised of the impending receipt of an ELM segment by the baseline transponder logic, it determines the upper four address bits of the

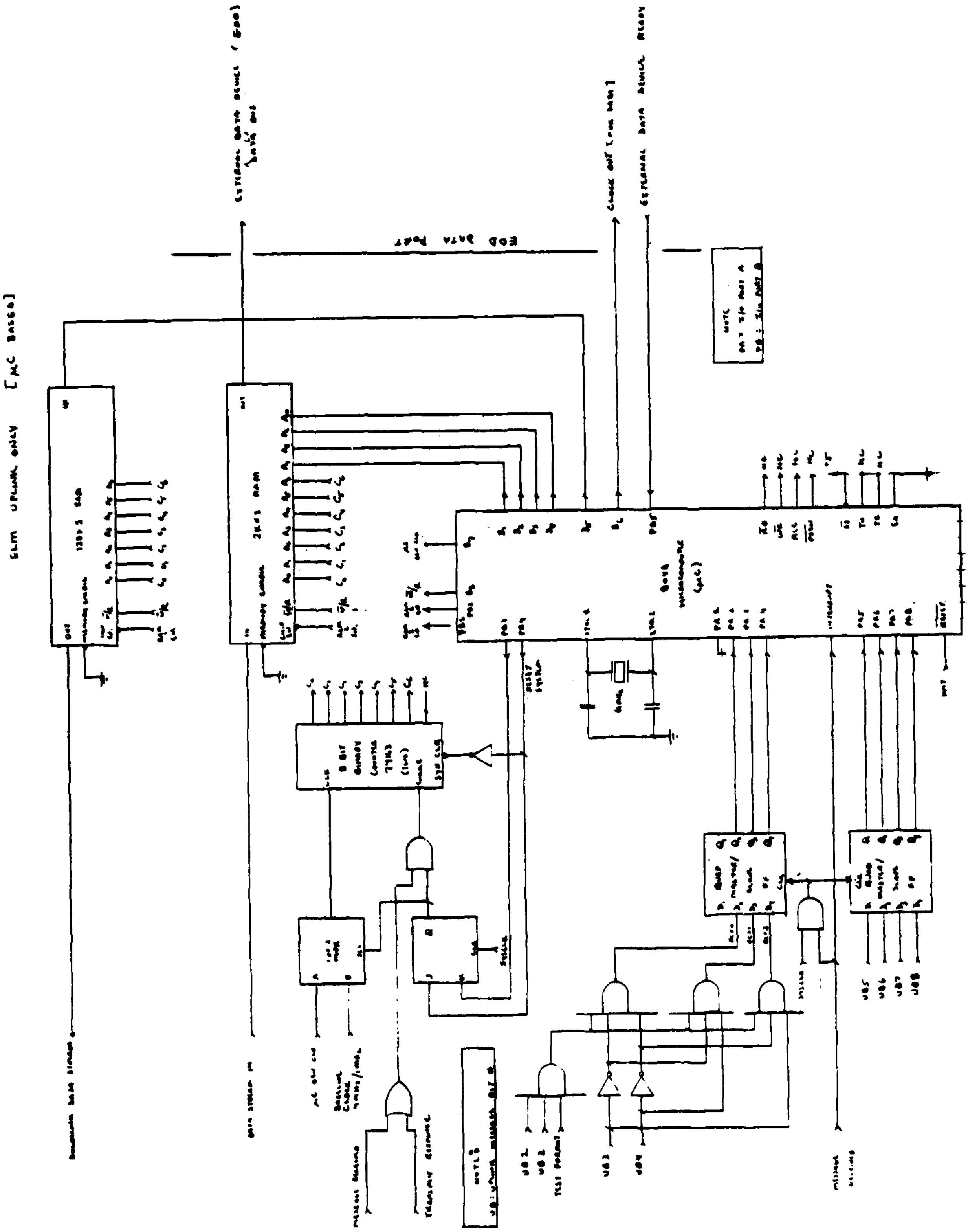


Figure E-27. ELM UPLINK ONLY

2Kx1 RAM such that the 80-bit segment is stored in one of sixteen 128-bit vectors. The selection of the least-significant seven address bits is accomplished by an eight-bit counter which is enabled by the microcomputer and a control signal from the baseline transponder (message received). The clocking is accomplished by the 4 MHz system clock from the baseline transponder control logic with the microcomputer selecting the proper clock input for the counter.

As each ELM segment is received, it is written into the 2Kx1 RAM. The microcomputer maintains a table correlating where each of the received ELM segments is stored; this table is then consulted when the segments must be extracted in order. The table also contains the basic data which is incorporated in the downlink reply which is prompted by the receipt of the (presumed) last ELM segment; this reply is formatted in a 128x1 RAM under microcomputer control. This basic data is included in the downlink response by the transponder logic which then controls the RAM through the TRANSMIT response which drives the binary counter driving the RAM.

When all segments have been received correctly, the microcomputer interacts with the external data device, which communicates to the microcomputer that it is prepared to receive the ELM segments. The microcomputer then transmits the ELM segments in order at a high data rate which presently has not been specified.

3.2 ELM Uplink and Downlink

As in the uplink-only version, the control component is a microcomputer which acts as a process controller. It interfaces to the baseline transponder logic and provides the liaison with both of the 2Kx1 RAMs used for storage of the ELM segments and the External Data Device (EDD) which buffers the segments. The ELM Uplink and Downlink is shown in Figure E-28.

The 8039 microcomputer utilized in this design is faster in speed than the 8048 (minimum cycle time of 1.36μsec as compared with 2.5μsecs). The 8039 depends upon the 8355 peripheral chip to provide the 2Kx8 ROM containing the instructions; the peripheral chip also provides two additional eight-bit data ports for input and output. The additional capability is necessary because of the added responsibilities the system must assume in order to handle the downlink ELM segments.

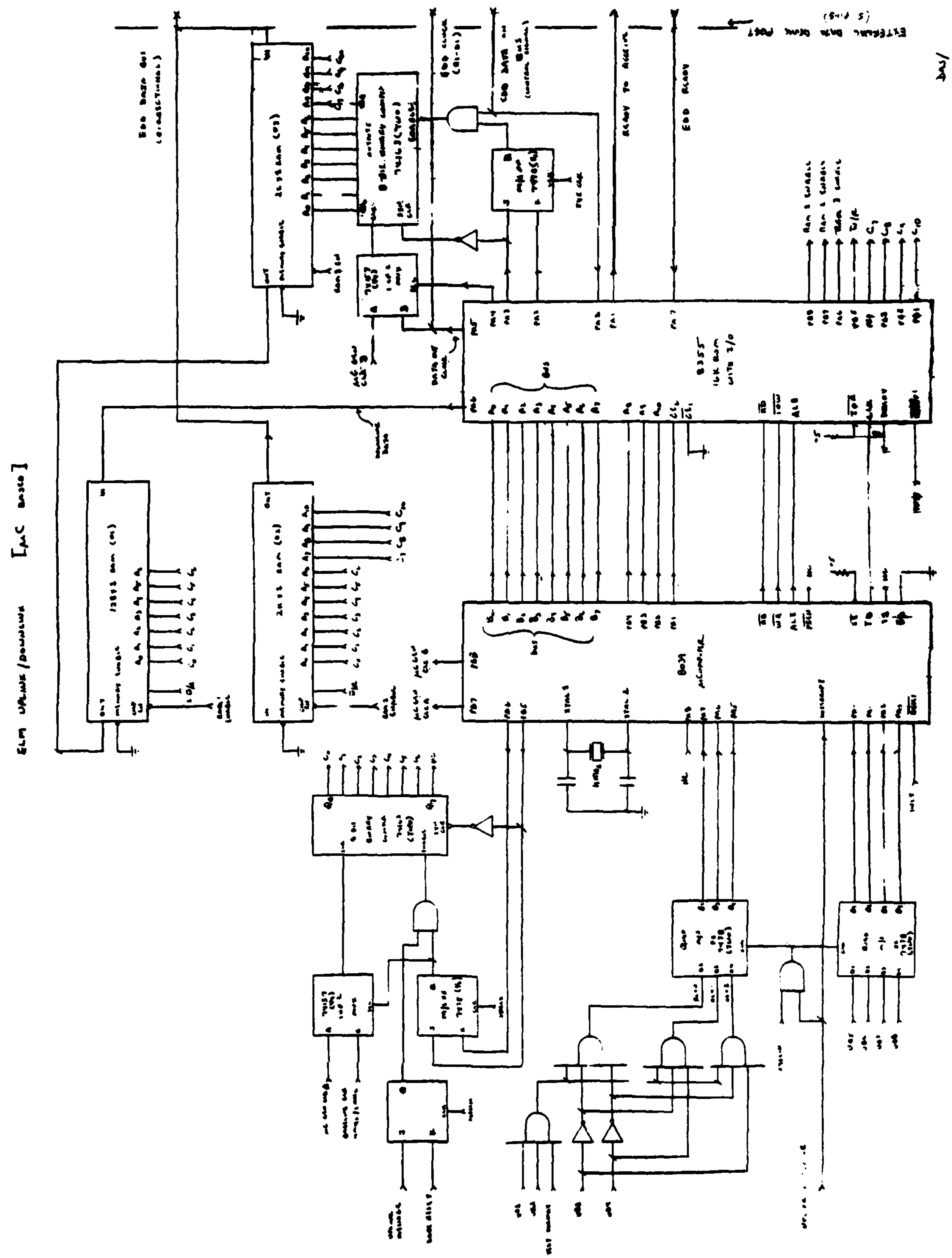


Figure E-28. ELM UPLINK/DOWNLINK

The 8039 microcomputer performs all of the tasks associated with the ELM downlink design. In addition, it interacts with the EDD to obtain the ELM segments destined for downlink transmission. The EDD obtains the raw data and converts it into a number (maximum of sixteen) of segments; it then notifies the microcomputer that it has a number of segments available for transmission. At a free time, the microcomputer instructs the EDD to send a segment; this is written into a 2Kx1 RAM. This process continues until all segments are written into the RAM. The EDD writes additional information into the RAM which informs the microcomputer of the number of segments to be transmitted. Upon completion, the microcomputer interacts with the baseline transponder to formulate the downlink transmissions. Necessary data is written in the 128x1 RAM which is dumped as part of the downlink message.

The ELM Uplink/Downlink system has two principle functions: uplink and downlink ELM interaction. The uplink system has priority, since the data must be handed over as it arrives and the microcomputer must be ready when it occurs. The interaction with the EDD for the transmission of uplink segments and the receipt of segments destined for downlink transmission are handled by the microcomputer when it is idle (i.e., not receiving uplink segments). This system relies on the EDD, 1) to receive and transmit ELM segments at a high data rate and 2) to buffer the data to and from the terminal or other data input/output device.

As in the uplink, the microcomputer allows data to be written into the 2Kx1 RAM with minimal overhead. The microcomputer selects a RAM vector where the next segment will be stored. A counter is then enabled such that the presence of a clock from the EDD will drive the counter and generate the addresses necessary to write the data into the RAM.

*U.S. GOVERNMENT PRINTING OFFICE: 1982 361-428/1565 1-3